INCIDENCE AND VARIATION OF CORONA MORTIS IN INDIAN POPULATION

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Submitted By

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I hereby declare that the thesis entitled "**INCIDENCE AND VARIATION OF CORONA MORTIS IN INDIAN POPULATION**" submitted towards partial fulfillment of the requirements for the award of **MS in Orthopedics** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Harpal Singh Selhi**, Professor, Department of Orthopedics, **Dr. Kavita Saggar,** Professor & Head, Department of Radiodiagnosis and **Dr. Meenakshi Aggarwal**, Associate Professor, Department of Anatomy. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated to
My
Loving
Grandmother
Mrs Jasbir K.
Aulakh

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Dr. Harshaan Singh Pooni

ABBREVIATIONS

CMOR	Corona Mortis
CTA	Computed Tomographic Angiography
EIA	Eternal Iliac Artery
EIV	Eternal Iliac Vein
IEA	Inferior Epigastric Artery
IEV	Inferior Epigastric Vein
IIA	Internal Iliac Artery
IIV	Internal Iliac Vein
OA	Obturator Artery
ORIF	Open Reduction Internal Fixation
SPR	Superior Pubic Rami

ABSTRACT

Introduction: The Corona Mortis (CMOR), also known as the “Crown of Death”, is a horrifying name that serves to represent the high risk of hemorrhage that may occur if this anatomical variant is injured in pelvic trauma or intra-operatively and the difficulty of achieving hemostasis. Corona mortis is defined as an arterial or venous anastomosis between Internal Iliac (Obturator Artery) and External Iliac (Inferior Epigastric Artery) arteries over the superior pubic ramus.

Aim of Study: To study the incidence and variations of Corona Mortis in surgically operated pelvic ring injuries via Anterior approach to pelvis, radiological (CT angiography) and anatomical specimens (cadaveric)

Duration of study- 18 months(1st February 2022 till 31st August 2023)

Material & Methods: Patients admitted in Department of Othopaedics with unstable pelvic ring injuries requiring Open Reduction Internal Fixation via Ilioinguinal approach or Modified Stoppa’s approach to pelvis.150 consecutive CT angiographies of patients in Department of Radiology and 16 cadaveric hemipelvis dissected in the Department of Anatomy to locate and note incidence, type and distance of CMOR from pubic symphysis.

Results: In a total of 359 hemipelvis studied which included surgical cases(43), radiological CTA(300) and cadavers(16), Incidence rate of CMOR ranged from 17.3% to 62.5% based on surgical(27.9%), radiological(17.3%) and anatomical(62.5%) evidence. No variations were present in the incidence or distance of CMOR from pubic symphysis between religion or among genders except in radiological study group(p=0.002) in which female hemi-pelvis had a higher mean distance of the anastomosis from pubic symphysis as compared to male(58.79 mm vs 54.06 mm)

Conclusion: With this variable incidence rate, meticulous dissection during pelvic surgeries is essential to avoid complications. Gender-specific anatomical differences should be considered necessitating tailored surgical approaches. Increasing awareness among surgeons is vital for improving CMOR management.

Keywords: Corona mortis, anastomosis with obturator artery, incidence, CT angiography, Modified Stoppa’s approach, Ilioinguinal approach, pubic rami fractures
fracture, pelvic ring injury

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INTRODUCTION

Pelvis as a structure is inherently designed to be highly stable by nature. Pelvic ring fractures are most frequently observed in the context of high-impact trauma and are frequently accompanied by other fractures or injuries in other parts of the body. Particular pelvic fractures, such as iliac wing fractures, do not disrupt the pelvic ring and can be typically managed without the need for surgical intervention. Unstable pelvic fractures and fractures leading to disruption of pelvic ring require surgery.

The pubis, ischium, and ilium constitute the bony pelvis. An anatomic disc is formed by these structures and the sacrum. The anterior aspect of the pubic symphysis is stabilized by the symphyseal ligaments. The pelvic ring is stabilized on the posterior aspect by the posterior sacroiliac complex and pelvic floor ligaments (Sacrospinous and Sacrotuberous) which are situated anterior to the sacroiliac joint, are capable of resisting both shear and external rotation through the sacroiliac joint. The most posterior ligament in the pelvic ring and the most critical structure for pelvic ring stability is the posterior sacroiliac complex. The posterior ligaments are injured through a mechanism of injury that is extremely high-energy.[1] Typically, pelvic ring injuries are diagnosed in conjunction with severe soft tissue disruption. Consequently, it is imperative to exclude vascular, neurologic, and visceral injuries, which are frequently associated with Pelvic trauma. The majority of haemorrhage associated with pelvic ring trauma is caused by the injury to the vascular plexus of the posterior pelvis. Clinical hypoperfusion and an increase in abdominal mass are early indicators of vascular injury. Therefore, the presence of a corona mortis poses a threat and should not be disregarded in the context of these fractures.

Excessive blood loss within the pelvis can rapidly lead to a negative outcome as a consequence of direct trauma or as intraoperative damage to Corona Mortis.[2]

The Corona Mortis is an anastomosis that connects the External Iliac and Obturator Artery (A branch of the Internal Iliac Artery).

This collateral circulation is the result of the Inferior Epigastric or Accessory Obturator Artery, which originates from the External Iliac Artery, joining the Obturator Artery, which originates from the Internal Iliac Artery. The Obturator Artery typically originates from the anterior trunk of the Internal Iliac Artery. On occasion, it may develop from the External Iliac or Femoral Artery rather than the Internal Iliac Artery. The Accessory Obturator Artery typically originates from the External Iliac Artery. Additionally, the Inferior Epigastric Artery may originate from a common trunk of either the External Iliac or Femoral Artery, and the Obturator or Accessory Obturator Artery may also arise.[3]

The Anterior Division of Internal Iliac Artery is the source of the Obturator Artery (OA), which travels along the lateral pelvic wall and is accompanied by the Obturator Nerve and Vein. It exits the pelvis through the obturator foramen. It provides Iliac, Vesical, and Pubic branches in the pelvis. Upon entering the obturator canal, it is divided into anterior and posterior branches to supply the medial compartment of the thigh.[4] OA has been reported to have a diverse origin by numerous authors. The Obturator Artery is occasionally supplanted by an enlarged pubic branch of the Inferior Epigastric Artery, which descends into the obturator foramen. A distended Pubic Vein, which connects to the External Iliac Vein, may also serve as a substitute for the Obturator Vein.

The Corona Mortis (CMOR) is a vascular variant of significance due to its high propensity to haemorrhage, which led to its sensational name. It is characterized as an anatomical variant with a variable incidence, size, and location. Ethnic and regional disparities are also evident in the prevalence of these vascular connections.

The significance of this feature is underscored by the term "Corona Mortis" or Crown of Death, as it is challenging to achieve subsequent hemostasis and significant haemorrhage may result if it is inadvertently cut.[5] Darmanis

et al. (2007) presented persuasive arguments to support a paradox: in anatomical dissections, a substantial vessel was identified behind the superior pubic ramus; however, in clinical practice, this vessel does not appear to pose as significant a threat as initially believed. Despite the fact that the corona mortis is typically considered to be arterial, it may be venous, arterial, or both. The diameter of the connecting vessel ranges from 2.0 to 4.2 mm.[6] It appears that there are no substantial disparities between genders in the frequency of Corona Mortis and the distance between the symphysis pubis and the communicating vessels.

In one investigation, the prevalence of a venous Corona Mortis ranges from 27.4 to 100%.[7] Whereas the prevalence of its arterial counterpart 14.85 to 36%.[8] The high variability of the formation of Corona Mortis has been confirmed by recent anatomical investigations. This aberrant vein or artery has a significant position in the orthopaedic and trauma literature due to its susceptibility to injury in the event of pelvic trauma, as it crosses the Superior Pubic Ramus. Additionally, general surgeons are apprehensive about the potential complications that may arise during laparoscopic hernia repair. Interventional radiologists have recently expressed interest in identifying it through CT and angiography in order to proceed with embolization. The corona mortis is a critical, yet lesser-known, component of urogynecological surgery, particularly in the surgical management of stress urinary incontinence.

Although literature from the Western world is readily available to serve as a guide, it would be advantageous to have more pertinent data from our Indian population. The primary goal of this investigation was to ascertain the prevalence of CMOR in patients, CT angiographies, and cadaver hemipelvis. The objective is to ascertain the mean incidence, average distance from pubic symphysis and subtypes of the CMOR.

The literature contains a motif of debate regarding the prevalence of this connection, as there are discrepancies in the rates reported in various studies.

Therefore, orthopaedic surgeons must possess an understanding of the incidence, magnitude, and anatomical relationships of the Corona Mortis, particularly during the anterior pelvic approach via Modified Stoppa's or Ilioinguinal Approach. This information is essential for the prevention of complications associated with the iatrogenic rupture of this vessel.

The majority of research on Corona Mortis was conducted on cadavers or 3D CT angiography, with very few studies conducted on the Indian population. The objective of this investigation is to investigate the Incidence and Variations of Corona Mortis in Anatomical (Cadaveric), Radiological (Angiography), and Intraoperative patients within the Indian population.

AIMS AND OBJECTIVES

An observational study based on evidence from patients (Minimum 25) who underwent operative management (ORIF) of fracture of the pelvic ring via Anterior approach within the study period, **Radiological** (150 consecutive CT Angiographies) and **Anatomical** (8 cadavers i.e.16 cadaveric hemipelvis) subjects done over a period of 18 months from 1st February 2022 till 31st August 2023.

To study the following-

1. The Incidence of Corona Mortis (CMOR)
2. In cases with presence of CMOR to determine distance of Corona Mortis from Pubic Symphysis
3. Variations of Corona Mortis in relation to gender and religion with incidence and distance of anastomosis from Pubic Symphysis

REVIEW OF LITERATURE

The anastomotic connection between the Obturator and External Iliac vascular systems is represented by the Corona Mortis. The significance of this feature is underscored by the term "Corona Mortis" also known as The Crown of Death, as it is challenging to achieve subsequent hemostasis and significant haemorrhage may result if it is inadvertently cut. The surgical relevance of the vascular relations of the superior rami of pubis necessitates a comprehensive understanding of the morphological and topographical potential of the crown of death, as well as the individual assessment of this perilous anatomical structure. [9] Ethnic disparities can influence the prevalence of this anastomosis. Anastomoses were established between the external iliac and obturator systems in 83% of English [5] 80% of Romania, [9] 77% in Thais, [10] 72% of Chinese, [6] 61% of Turkish [8] of the studied specimens. In 20% of the specimens, both arterial and venous connections were observed. [11]

In the various ethnic populations, accessory branches of the Obturator Artery were observed in 8%, 14.81%, 19%, and 34%.[7,11,12,13] In classical anatomy textbooks, the veins that constitute the Corona Mortis are described less frequently than the arteries. This vein connected to the obturator vein and coursed vertically to the inferior border of the superior pubic ramus. [7] Venous anastomosis on the superior pubic ramus are a finding in 96%, [7] 70%, [11] 40%, [14] 20.37% [12] of cases. The average distance from the symphysis to the anastomotic vessels was 6.2 cm. [11] As per literature the range between the anastomotic arteries and pubic symphysis is 45-90 mm with average of 64 mm while the range between communicating vessels is 37-80 mm with average of 56 mm. [8] The modified Stoppa’s approach frequently employed to treat acetabular fractures, which poses a risk of injuring Corona Mortis during the surgical exposure. A medial approach for pelvic osteotomies for acetabular dysplasia also poses a risk to the Corona Mortis.

To prevent a calamitous complication, surgeon must have a comprehensive understanding of the anatomy of Corona Mortis to prevent iatrogenic injury.

Embryological basis

In 1993, Sañ udo et al.*,* [15] suggested a novel ontogenetic theory. They contend that the OA may initially develop as an independent blood vessel from the rete femorale and rete pelvicum, but blood flow to its territory originates from the IEA. This theory not only explains the concomitant association between accessory/aberrant obturator vessels in selected cases but also accounts for the various anomalies surrounding the origin of the OA.

RELEVANT BONY AND VASCULAR ANATOMY OF THE PELVIS [16]

Obturator foramen

The obturator foramen is situated between the pubis and ischium, slightly anterior to and below the acetabulum. It is bounded by the grooved obturator surface of the superior pubic ramus above, the pubic body and its inferior ramus medially, the ischial ramus below, and the anterior border of the ischial body, which includes the margin of the acetabular cleft, laterally. In males, the foramen is quite large and oval, while in females, it is tiny and nearly triangular.

Superior pubic ramus

It has three surfaces and borders and is triangular in shape. Its anterior, pectineal surface is triangular in shape and extends from the pubic tubercle to the iliopubic eminence, with a minor upward tilt.The posterior surface of the body is circumscribed above by the pecten pubis and below by a sharp inferior border. The posterosuperior, pelvic surface is smooth and medially inclined, narrowing into the body. The inferior border is its posterior limit, while the obturator crest is its anterior limit.

Pecten pubis

The pecten pubis is the superior, sharp border of the pectineal surface. At its medial extremity, the lacunar ligament and conjoint tendon are connected. The remainder of its surface is affixed with a robust fibrous pectineal ligament. Transmitting the obturator vessels and nerve from the pelvis to the thigh, the obturator fissure is transformed into a canal by the upper borders of the obturator membrane and obturator muscles. The lateral extremity of the obturator crest is the site of attachment for a few fibers of the pubofemoral ligament.

VASCULAR SUPPLY [17]

The Internal Iliac Arteries and Veins, that drain the preponderance of the pelvic viscera, are located within the true pelvis. The Common and External iliac vessels, that evacuate the lower limb, are located in the lower retroperitoneum and along the pelvic brim.

Right common iliac artery

The Right Common Iliac Artery is approximately 5 cm in length and passes obliquely across a portion of the fourth and fifth lumbar vertebral bodies. The parietal peritoneum envelops it, thereby separating it from the small intestine's coils. The Inferior Vena Cava and the right Common Iliac Vein are located lateral to its upper portion, while the right psoas major is located lower down.

Left common iliac artery

The Left Common Iliac Artery is approximately 4 cm in length and is shorter than the right. The superior rectal artery, the ureter, and the sympathetic rami to the pelvic plexus are situated anterior to it at its terminal bifurcation. The obturator nerve, lumbosacral trunk, iliolumbar artery, fourth and fifth lumbar vertebral bodies, and intervening disc are all situated posterior to it. The left psoas major is located lateral to the artery, while the Left Common Iliac Vein is posteromedial to it.

Internal iliac arteries

Each Internal Iliac Artery is 4 cm in length and originates at the Common Iliac bifurcation, which is located at the level of the lumbosacral intervertebral disc and anterior to the sacroiliac joint. It descends posteriorly to the superior margin of the greater sciatic foramen, where it is divided into an anterior trunk that continues in the same direction towards the ischial spine and a posterior trunk that returns to the greater sciatic foramen.

Internal iliac vein

The Internal Iliac Vein is the result of the convergence of multiple vessels above the greater sciatic foramen. It ascends posteromedially to the Internal Iliac Artery, where it joins the External Iliac Vein to form the Common Iliac Vein at the pelvic margin, anterior to the lower part of the sacroiliac joint.

Obturator vein

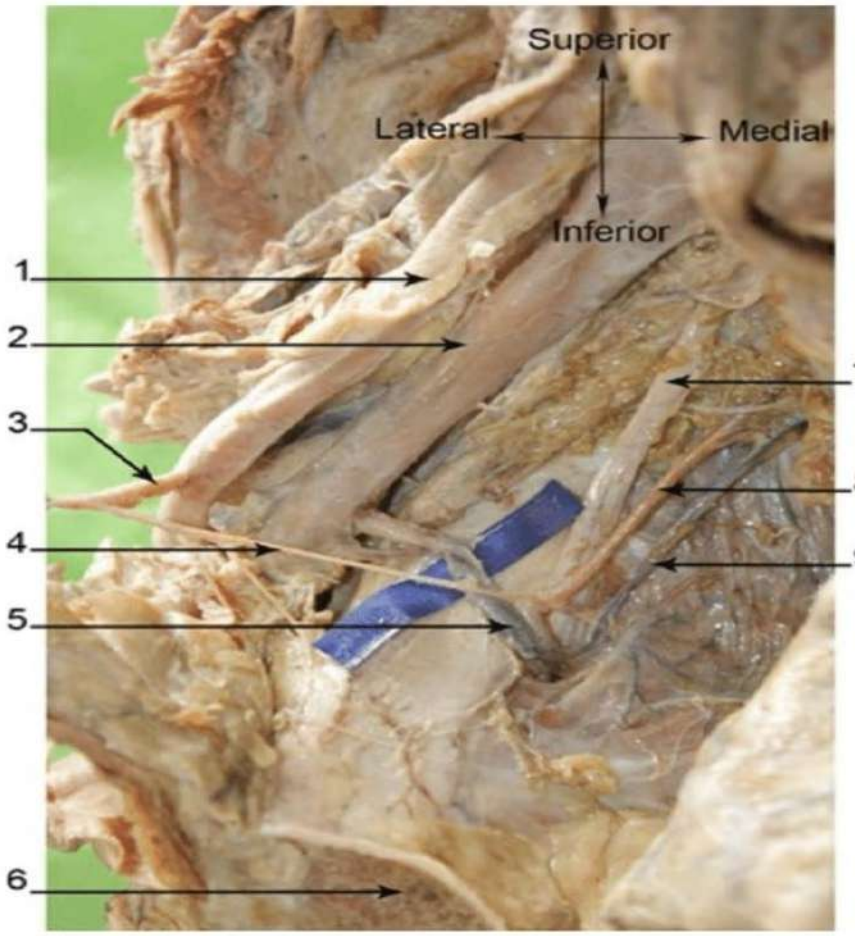
The Obturator Vein originates in the proximal adductor region and enters the pelvis through the obturator foramen. It terminates in the Internal Iliac Vein after running posteriorly and superiorly on the lateral pelvic wall, below the Obturator Artery and between the ureter and Internal Iliac Artery.

External iliac arteries

The Internal Iliac Artery is of a smaller caliber than the External Iliac Artery. From the common iliac bifurcation to a point midway between the anterior superior iliac spine and the symphysis pubis, each artery descends lateral along the medial border of the psoas major. The femoral artery is formed when it penetrates the thigh posterior to the inguinal ligament.

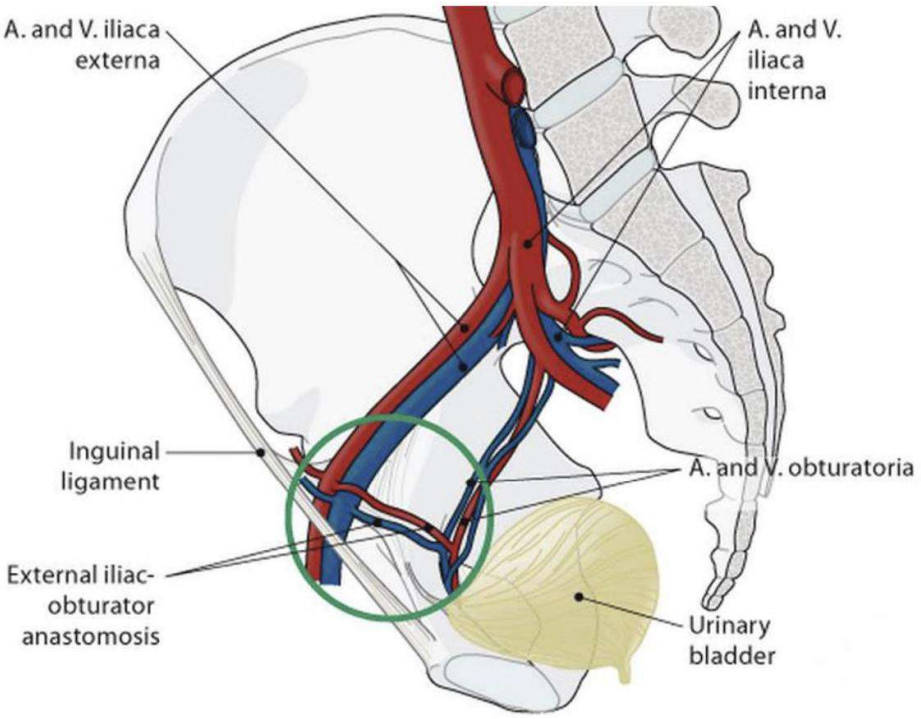
External iliac vein

The External Iliac Vein is the proximal continuation of the Femoral Vein. It commences posterior to the inguinal ligament, ascends along the pelvic brim, and terminates anterior to the sacroiliac joint by merging with the Internal Iliac Vein to create the Common Iliac Vein. It is situated medial to the External Iliac Artery on the right side, progressively inclining behind it as it ascends. It is entirely medial to the External Iliac Artery on the left, which may result in it adhering closely to the vein at the location.



-Right side, combined arterial and venous corona mortis (Type-IIIc: anastomosis between pubic branch of inferior epigastric artery artery and pubic branch of obturator artery, venous anastomosis between obturator and external iliac veins). 1 external iliac artery, 2 external iliac vein,3 inferior epigastric artery, 4 anastomosis between pubic branch of IEG artery and pubic branch of obturator artery, 5 Venous anastomosis between obturator and external iliac vein, 6 pubic symphysis, 7 obturator nerve, 8 obturator artery, 9 obturator vein.

PICTURE 1: Cadaveric representation of CMOR [18]



PICTURE 2: Graphical representation of CMOR[19]

Retropubic vascular anastomoses

According to the original description found in the 34th edition of Gray's Anatomy (Davies and Coupland, 1967) and that given by Letournel and Judet (1993), CMOR can be defined as an anastomotic communication between the Obturator and the External Iliac/Inferior Epigastric arteries/veins.[5]

Further light was shed by Rusu et al., [9] who stated that any major vessel, regardless of its origin, that entered the obturator canal constituted the OA. The authors also stated that the larger vessel would be classified as OA, while the other would be deemed the accessory vessel if more than one artery entered the upper border of the obturator foramen. Additionally, the sole existing OA must be regarded as the OA in the absence of any

other. Therefore, an accessory aberrant OA is a supplemental artery that has OA but follows an aberrant course through the obturator foramen.

Arterial and venous CMOR

Rusu et al.[9], classified CMOR on the basis of their respective vascular composition into three major types:

Type 1: Pure arterial CMOR.

Type 2: Pure venous CMOR.

Type 3: Combination of arterial as well as venous CMOR.

Arterial and venous anastomoses are further divided into four and three subtypes respectively

Type 1-1. Obturator artery (OA) arising from the external iliac artery (EIA).

Type 1-2. OA leaving the inferior epigastric artery (IEA).

Type 1-3. Anastomosis of the OA and IEA.

Type 1-4. pubic branch(es) from the OA, un-anastomosed to the external iliac system but traversing over the superior pubic branch.

Type 2-1. Obturator vein (OV) draining into the external iliac vein (EIV).

Type 2-2. OV draining into the inferior epigastric vein (IEV).

Type 2-3. Venous anastomosis of the OV and IEV.

The incidence of arterial CMOR reported in literature varies from 8% to as high as 65%. [20] In 150 hemipelvis specimens, 29 arterial anastomoses were reported by Okcu et al. (19%). On the other hand, Darmanis et al.[5] reported a 36% incidence rate in their investigation of 80 cadaveric halves. Mahato et al.[21] observed arterial CMOR channels in 11 of the 50 cases (22%). The aggregate incidence of arterial CMOR is estimated to be between 8.2% and 8.3%, according to the results of the two most recent research papers. Interestingly, both studies have been performed on different sections of the Indian population, Nayak et al. [22] on south Indian subjects and Kashyap et al.[20] on north Indian patients.

Reported incidence rates of venous CMOR have varied from 40% to 96%. [7] In one of the earliest cadaveric studies, Tornetta [11] reported that venous

connections accounted for up to 70% of their anastomotic channels. Venous CMOR have been noted by Pellegrino et al. [23] in 48% cases, Okcu et al.[8] in 52% cases, Rusu et al.[9] in 55% cases and most recently, by Kashyap et al.[20] in 58.5% cases.

Laterality

The anastomotic vessels have been observed to be more prevalent on the right side in certain cadaveric investigations, while others have observed the opposite. In three out of 69 cases (4.3%), Nayak et al.[22] reported bilateral CMOR. The incidence reported in other studies was significantly higher. Okcu[8] identified 21 bilateral vascular connections during the dissection of 150 cadaveric hemipelvis specimens. Nevertheless, bilaterally symmetrical findings were observed in only nine cases (12%). Darmanis et al.,[5] in contrast, had identified bilateral vascular anomalies in 34 of the 40 cases, with bilaterally symmetrical distributions observed in two specimens.

Distance from the pubic symphysis and caliber

The CMOR is located at a variable distance from the pubic symphysis and different values have been described in different studies. The same rationale applies to the vessel diameter. Cardoso et al.[24] have pegged the average caliber of the CMOR vessels at 2.8 mm.

As per study done by Robert et al[25] in Twelve dissections that were performed without perfusion, the mean distance between the CMOR and the pubic symphysis was 58.02 ± 6.27 mm whereas in twelve other hemipelvis that were prepared with the SIMLife® pulsatile perfusion The mean distance between the CMOR and the pubic symphysis 60.97 ± 9.94 mm.

As assessed by Kashyap S et al[20] in a study, on average, CMOR were present 5.6 cm (range, 3.5-7.0 cm) lateral to the pubic symphysis.

The anastomosing vessel is reported to be found ~50 mm (range: 35-72 mm) from the pubic symphysis. The vessel itself ranges in diameter from

1.4-3.7 mm and may be occluded in patients with peripheral vascular disease . [26]

Berberoğlu et al[7] showed in their anatomical study, the CMOR diameter was about 3.3.mm (ranging from 2.2 to 4.9 mm), whereas in laparoscopic findings the diameter was less than 1 mm).

Imaging modalities

In a study evaluating the extent of blood loss in pelvic-acetabular osteotomies, Hu et al. [27] were able to identify CMOR vessels in 21 out of 28 (75%) cases using Magnetic resonance imaging (MRI). Magnetic resonance venography (MRV) has shown to be superior to contrast venography for detecting deep vein thrombosis in pelvic veins in patients with acetabular fractures and is a promising modality for imaging veinous CMOR connections.

Clinical relevance in pelvic-acetabular surgery

The results of numerous cadaveric studies have revealed that the actual incidence of haemorrhage resulting from traumatic injury to the CMOR blood vessels is significantly lower than what one would anticipate. This discrepancy has been attributed to three potential causes. The initial theory posits that the vascular channels would undergo spasm as a result of any direct or indirect injury to the CMOR subsequent to a pelvic fracture. This would render their identification significantly more challenging during the surgical procedure. Another theory posits that the discrepancy observed in the clinical setting may be attributed to demographic and ethnic differences between sections of distinct study populations. The CMOR variant of obturator artery has a higher frequency in the European population than in the Asian community, as determined by a systematic review conducted to determine its prevalence and characteristics. The most recent theory posits that the EIA or OA may be occluded in the elderly due to atherosclerosis or deep vein thrombosis.

This would subsequently promote the formation of aberrant obturator blood vessels and collateral vascular channels in these individuals.

Causes of injury to Corona Mortis:

1. Fracture of the upper part of the obturator foramen, including SPR fractures, low anterior column fractures etc.
2. Iatrogenic injury during exposure to the anterior acetabulum (Ilioinguinal as well as modified Stoppa approach).
3. Coil embolization of the IIA and its various branches performed following excessive bleeding associated with pelvic injuries.
4. Acetabular dysplasia surgeries and pelvic osteotomies making use of the medial approach.

There has been a lot of debate surrounding the utility of pre-operative angiography for mapping the vasculature around the operative site. Jensen et al. [28] argued that such studies were actually not needed if a careful and gentle dissection was performed during surgery. The authors further stated that it was highly unlikely that CMOR could be the only source of bleeding in an unstable pelvic injury and under such circumstances, it would be wiser to first externally stabilize the pelvis. In the absence of clear-cut guidelines, the need of pre-operative angiography needs to be further studied in detail.

Khirul-Ashar 2024 evaluated the relationship between the incidence of CMOR and gender, race, and age, morphology and mean location of the ―crown of death‖ in the Asian population. This was cross-sectional cadaveric investigation that involves 164 fresh multiracial Asian hemipelves. CMOR was detected in 71.3% of the cases. The average distance between the CMOR and the symphysis pubis was 54.72mm. It was evident from the results that precautionary measures must be implemented within a 55mm radius of the symphysis pubis during any surgical procedure. They determined that CMOR is not merely an aberrant vessel, as the incidence is high, and this conclusion is consistent with other research. The mean location of CMOR obtained in this study will

serve as a guide for surgeons from a variety of disciplines in Asia in the management of traumatic vascular injury and the execution of a safe surgical procedure in the pelvis region. [29]

Özmeriç 2023 enhanced the surgical anatomical knowledge of pelvic/acetabular trauma surgeons by furnishing comprehensive morphometric data. The median distance from the corona mortis to the symphysis pubis was 59.5 mm. The pubic limb was bisected by the external iliac vein 68.5 mm lateral to the symphysis pubis. The obturator neurovascular bundle, superior vesical artery, and vaginal artery were located 15 mm, 24 mm, and 36 mm inferior to the pelvic brim at the level of pectineal convexity, respectively. In the supine position, the superior gluteal vessels exit the sciatic fissure at the 12 o'clock position. The inferior gluteal vessels exit the sciatic fissure at the 3:20 o'clock position. The SI joint is bisected by the common iliac artery bifurcation 5 mm superior to the antero-superior corner of the sacroiliac joint. The posterior trunk of the internal iliac artery extends 18 mm directly ahead of the antero-superior corner of the SI joint. The superior gluteal artery and lateral sacral artery bifurcated 11 mm from the starting point of the posterior truncus. The lateral margin of the L5 root was located on the SI joint, while its medial margin was 9 mm medial to this landmark. [30]

Bharathi D et al 2022 Estimated the prevalence and location of corona mortis in the South Indian population, frequency of occurrence and its morphometry. The dissection of 55 adult cadavers was conducted, and corona mortis was observed on the pelvic surface of the superior pubic ramus. The number of venous and arterial anastomoses was noted and photographed. The corona mortis was observed in 63.64% of the cases. It was observed in 69% male and 46% female cases. Venous anastomosis was observed between the obturator vein and the inferior epigastric or external iliac vein in all specimens. The anastomotic vessel remained consistent in both sexes, as the mean distance of the corona mortis vessel

from the pubic symphysis was 5.26±1.2 cm in males and 5.63±0.94 cm in females.[31]

Sengodan, V C 2022 ascertained the incidence and variations of corona mortis in the south Indian population. The research group consisted of forty hemipelves from 20 cadavers. Data regarding the presence or absence of corona mortis, the nature of corona mortis, and the distance between corona mortis and pubic symphysis were collected following dissection. Corona mortis was observed in 82.5% of the hemipelves. In 65% of the cadavers, it was bilateral. It was present in all female cadavers on both sides, while it was present in 75% of the 28 male hemipelves. The venous variant was present in 78.78% of hemiplegia, while the arteriovenous variant was present in 5.16% and the arterial variant was present in 6.06%. The median distance between the pubic symphysis and the corona mortis was 55.65 mm. In contrast to the arterial and arteriovenous variants, the venous variant dominated the investigation.[32]

Paz, SI 2022 presented a case of a 53-year-old female patient with a history of peripheral arterial disease who underwent angioplasty for limb salvage. The procedure resulted in a lesion to the Corona Mortis variant and a subsequent persistent pelvic haemorrhage. Coil embolization was employed to achieve hemostasis of extravasation, and the patient recovered without any complications.[33]

Abbas, A 2021 examined the anatomical and clinical implications of corona mortis in the anterior approaches to the pelvis and acetabulum on patients who sustained an anterior pelvic anterior acetabulum fracture and underwent open reduction internal fixation with reconstruction plates. Corona mortis was identified in 43% of the 30 pelvic halves. The Right hemipelvis specimens constitute 53.8% of the total, with 30.8% being arterial, 7.7% being venous, and 61.5% being a combination of both. Of these, 53.9% had a diameter greater than 5 mm, with the largest

measuring 80 mm. The mean distance from the symphysis was 5.8 + 1.6 mm. While only 13 patients have corona mortis, 53% of patients have an arterial diameter greater than 5 mm.[34]

George Noussios 2020 reported the frequency and anatomical variations of vascular corona mortis. PubMed, Scopus, and Google Scholar were utilized to coordinate a substantial investigation. The systematic evaluation of the articles discovered was conducted in accordance with the Prisma guidelines. In total, 1,455 patients and 13 investigations were incorporated into the statistical analysis. The findings indicated that corona mortis was present in approximately half of the hemipelvis, with a prevalence of 46%. Corona mortis of the venous type was more prevalent than that of the arterial type (42% versus 25%). In an effort to mitigate the risk of corona mortis injury during surgery, it is essential to possess anatomical knowledge of the region.[35]

Granite G 2020 Published case studies that emphasize Corona Mortis vascular variation. As per them anatomical instructors and surgeons have access to precise information regarding the prevalence of these variants and their identification through published case studies. The aberrant Obturator Artery was present in seven of the eighteen individuals (38.9%), while two of the eighteen individuals (11.1%) manifested with bilateral aberrant obturator arteries. A deep inferior epigastric artery-derived aberrant obturator artery was present in six of these individuals (33.3%). In one case, the external iliac artery was the direct source of an aberrant obturator artery (5.6%) (1 individual).[36]

Meng MD 2020 investigated the safety of the corona mortis during the minimally invasive plate insertion for the treatment of anterior pelvic ring fractures. The anterior ring minimally invasive plate was inserted into the corona mortis of eight adult cadavers during the simulation. The anastomotic branch was observed in the suprapubic branch area. Corona

mortis was observed in 75% of cases. The percentage of vein anastomosis was 43.75%, arterial anastomosis was 18.75%, and both arterial anastomosis and vein anastomosis were 12.5%. The diameter of the corona mortis was between 1.6 and 3.5 mm, and the distance between the capillaries and the pubic tubercle was between 53.9 and 65.2 mm. The corona mortis length ranged from 24.5 to 37.5 mm. The iliac or inferior epigastric vessel was the source of the corona mortis. It traversed the pubic branch to the dorsal side of the pubis and continued downward to anastomose with the obturator vessels in close proximity to the obturator. The corona mortis and pubis were separated by a maximal vertical distance of 8.8 to 18.3 mm. The incidence of corona mortis is high, and there are numerous variations in the morphology and type of blood vessels among patients.[37]

Bhoil R 2020 established the incidence of Arterial Corona Mortis variant in angiographic studies being performed using a 64 slice CT scan machine in a series of patients. This was a prospective cross-sectional study including 100 consecutive patients undergoing CT-angiography for the abdominal aorta and/or lower limbs using a 64 slice CT scanner. In total 200 hemi-pelvises were evaluated for the presence or absence of corona mortises. In this series 67 men and 33 women with mean age of 40.1 ± 2.3 years were included. The arterial variant was identified on thin, 0.625-mm-thick images in 24 out of 100 patients studied (unilateral in 20 patients and bilateral in 4 patients; 28 out of 200 hemipelvis evaluated, having an incidence of 14%). They found that the distance of corona mortis artery from the symphysis was significantly greater for women compared to men, both on right and left sides. Corona Mortis may be prospectively identified at contrast-enhanced multidetector CT especially in pelvic trauma patients and help guide subsequent endovascular embolization or surgical interventions.[38]

Perandini S (2018) conducted a study to assess the frequency and features of the Corona Mortis variation of the obturator artery using computed tomography angiography. This study retrospectively included 150 consecutive patients who were referred to CTA for the examination of vascular conditions in their lower limbs. During this analysis, it was found that 40.6% of patients displayed at least one proficient CMOR arterial anastomosis. Arterial anastomoses were observed in 30% of the 300 arteries that were examined, with 40 on the right side and 50 on the left side. Out of the total of 32 cases, a single anastomosis was observed in each case, while in the remaining 29 cases, the CMOR was bilateral. No anastomoses were seen in 89 patients. The mean distance from the symphysis was 50 mm. No significant correlation between hip osteoarthrosis and CMOR was found. The mean pelvic circumference measured 213 mm. The results of this analysis suggest that CMOR is a common variation that needs to be identified before pelvic intervention.[39]

Sanna B 2018 conducted a meta-analysis to furnish exhaustive information regarding the anatomical characteristics, prevalence, and ethnic variations of the corona mortis vessel. The data extracted included the investigative method, the prevalence of corona mortis vessels among hemi-pelvis, the distance from the corona mortis to the pubic symphysis, and the assessment of gender, side, laterality, and ethnicity subgroups. The meta-analysis encompassed 21 investigations and 2184 hemi-pelvis. The corona mortis is prevalent in hemipelvis on a general basis. A venous corona mortis is more common than an arterial corona mortis. The corona mortis is more prevalent in Asia than in Europe and North America. Due to the fact that a corona mortis is present in approximately 50% of all hemipelvis, it is crucial to anticipate its presence during surgical procedures and accordingly plan to prevent injuries. The anatomical characteristics and surgical implications of a corona mortis should be thoroughly comprehended by all surgeons who operate in the retropubic region.[40]

Papagrigorakis E et al 2018 revealed a variation in the incidence of Corona Mortis between cadaveric and patient investigations. New technological advancements, particularly CT angiography, have enabled the acquisition of more precise depictions and, as a result, more accurate estimates of the true prevalence of corona mortis in the retropubic region arteries. The objective of this review is to obtain the corona mortis incidence from the main CT angiographic studies in bibliography for the first time and compare it to the incidence of CMOR in the major cadaveric studies. The estimated incidence of arterial CMOR varies in the largest studies in bibliography from 14% to 33%. The incidence of CMOR in cadaveric studies varies from 19% to 65%. [41]

Leite TFO 2017 described the surgical and clinical applicability of arterial Corona Mortis and to report its prevalence. In order to acquire information regarding corona mortis, they dissected 60 hemipelvis that were fixed in a 10% formalin solution. Using a digital caliper, they determined the caliber and length of the obturator artery and its anastomotic branch. Arterial corona mortis was observed in 45% of the sample under investigation. The internal iliac artery was the most prevalent source of the obturator artery; however, there was a single instance in which it originated from the femoral artery. The anastomotic branch had an average caliber of 2.7mm, while the obturator artery had an average caliber of 2.6mm. The vascular connections between the obturator, internal iliac, external iliac, and inferior epigastric arterial systems are relatively prevalent in the upper pubic branch. The anastomotic artery's trajectory and diameter may fluctuate. Therefore, the patient's life may be jeopardized by severe haemorrhage caused by iatrogenic lesions and pelvic and acetabular fractures.[42]

Al Talalwah W 2016 provided a sufficient data regarding vascular variability that crosses the pubic rami. This investigation contains 208 hemipelvis that were dissected. The obturator artery and its accessory, which crossed the superior rami of the pubic bone, were discovered to

have distinct origins during dissection. The external iliac artery and the femoral artery are the sources of the obturator artery, which accounts for 9.8% and 1.1%, respectively. Consequently, it passes over the superior pubic rami in 10.9% of cases. Additionally, the accessory artery is exclusively derived from the femoral artery in 1.1% of cases. This study examines the vascular variation that crosses the superior pubic rami, which is referred to as corona mortis, between the external and internal iliac systems, with or without collateral circulation. The corona mortis was detected in 12% of the Austrian population. Prior to performing pubic surgical procedures, including the internal fixation of pubic fractures and the closure of inguinal hernias, clinicians must exercise considerable caution. Additionally, large-scale haemorrhage may result from a traumatic pubic rami fracture as a result of the obturator artery's laceration.[43]

Jensen KO et al 2015 conducted A retrospective study to examine the incidence and surgical relevance of the CMOR, taking into account the intra- and peri-operative findings. All consecutive patients who underwent pelvic surgery as a result of pelvic ring instability or an acetabular fracture were analyzed. The data of 130 consecutive patients was assessed. The prevalence of the CMOR was 41.5%. The presence of the CMOR did not appear to be significantly correlated with haemorrhage complications or mortality. The presence of the CMOR or bleeding complications did not significantly influence the mortality rate. The high incidence of the CMOR is underscored by this study. Nevertheless, it is not linked to mortality or haemorrhage complications. Consequently, it does not appear to be the primary source of haemorrhage in pelvic trauma in the event of delayed surgery and can be considered a controllable anatomic structure.[28]

Jason CS 2009 investigated if contrast-enhanced multidetector computed tomography can visualize the "corona mortis," which is a frequently occurring form of the obturator artery that arises from the external iliac artery system and is vulnerable to pelvic injuries. The researchers

assessed a total of 50 consecutive patients who underwent contrast-enhanced multidetector CT of the pelvis. Out of them, 25 patients were scanned using a 16-slice scanner, while the remaining 25 were scanned using a 64-slice scanner. Three data sets were generated, namely: (a) a 5 × 5-mm axial data set, (b) a 1.25 × 1.0-mm axial data set, and (c) a 1.25 × 1.0-mm coronal data set. We assessed 100 hemipelves in a cohort of 50 individuals. A total of 29 corona mortises were found, with 10 recognized on the 5-mm axial images, 25 on the 1.25-mm coronal images, and 29 on the 1.25-mm axial images. The corona mortis variation can be detected in approximately 33% of patients with regular contrast-enhanced multidetector CT scans. The frequency of this fluctuation is observed more often in thin (1.25-mm) CT reconstructions compared to images that are 5-mm-thick. These findings indicate that the corona mortis might potentially be detected with contrast-enhanced multidetector CT in patients with pelvic trauma and can assist in determining the need for endovascular embolisation.[44]

It is reasonable to assume that CMOR is more frequently a venous anastomotic channel between the external and internal iliac systems. Another noteworthy characteristic is that a venous anastomotic connection is more challenging to manage in the event of an inadvertent injury during the surgical procedure. This anatomical fact directly influences the timing of surgical intervention in methods that are designed to address fractures and comminution in the quadrilateral plate region. The dissection of the anastomotic connections in the quadrilateral plate region is facilitated by a recent injury. The gumming up of vascular channels and the formation of fibrous tissue and callus in the area are frequently the result of surgical delays, which increases the difficulty of surgical dissection and increases the risk of vessel injury during the procedure.

Additionally, there may be multiple anastomotic connections, whether they are arterial, venous, or both. This information is relevant to the pelvi-

acetabular surgeon during the surgical procedure, as the surgeon and the surgical team should not be distracted by the identification of a single anastomotic channel from the potential for additional anastomotic connections between the external and internal iliac vascular systems. It is crucial for all surgeons and surgical teams to have a comprehensive understanding of the vascular anatomy of the CMOR and other communicating channels, regardless of their name. The number, location, size, and obliquity of these channels are all significant indicators of their origin, and surgical teams should exercise extra caution to prevent major or catastrophic complications. The size and position of the vascular anastomotic channels are also significant factors that influence the odds of iatrogenic injury that might result in uncontrollable bleeding.

Study	Objective	Sample	Findings
Khirul-Ashar (2024)	Evaluate CMOR incidence and its relationship with various factors in the Asian population	164 fresh multiracial Asian hemipelves	CMOR detected in 71.3% of cases; mean distance from symphysis pubis: 54.72mm; recommended precautions within 55mm radius
Özmeriç (2023)	Enhance anatomical knowledge for pelvic/acetabular trauma surgery	Data from surgical anatomy	Median distance from CMOR to symphysis pubis: 59.5 mm; various distances for associated vessels provided
Bharathi D et al. (2022)	Estimate prevalence and location of CMOR in the South Indian population	55 adult cadavers	CMOR observed in 63.64% of cases; 69% in males and 46% in females; consistent anastomotic vessel distances between genders
Sengodan, V C (2022)	Determine incidence and variations of CMOR in South Indian population	40 hemipelves from 20 cadavers	CMOR in 82.5% of hemipelves; bilateral in 65% of cadavers; venous variant dominant
Paz, SI (2022)	Case study of CMOR injury during angioplasty	53-year-old female patient	Persistent pelvic hemorrhage controlled with coil embolization
Abbas, A (2021)	Examine CMOR implications in pelvic/acetabular fracture surgeries	30 pelvic halves	CMOR in 43% of cases; different prevalence for arterial, venous, and combination types; important for surgical planning
George Noussios (2020)	Report frequency and anatomical variations of CMOR	1,455 patients across 13 studies	CMOR present in ~50% of hemipelvis; venous CMOR more prevalent than arterial
Granite G (2020)	Case studies on vascular variations of CMOR	18 individuals	Various origins of aberrant obturator arteries noted
Meng MD (2020)	Investigate CMOR safety during minimally	8 adult cadavers	High incidence of CMOR; detailed measurements of

	invasive pelvic surgeries		CMOR diameter and distances
Bhoil R (2020)	Establish incidence of arterial CMOR via CT angiography	100 patients (200 hemipelvis)	Arterial variant in 14% of hemipelvis; distance differences between genders noted
Perandini S (2018)	Evaluate prevalence and characteristics of arterial CMOR	150 patients	40.6% exhibited CMOR; various bilateral and unilateral anastomoses identified
Sanna B (2018)	Meta-analysis of CMOR prevalence and characteristics	21 studies, 2184 hemipelvis	CMOR prevalent in ~50% of hemipelvis; venous CMOR more common; higher prevalence in Asia
Papagrigorakis E et al. (2018)	Compare CMOR incidence in cadaveric and patient studies	Various studies	Higher precision in detecting CMOR with CT angiography; varied incidence rates reported
Leite TFO (2017)	Describe surgical/clinical implications of arterial CMOR	60 hemipelvis	Arterial CMOR in 45% of samples; variations in origin and trajectory noted
Al Talalwah W (2016)	Provide data on vascular variability crossing pubic rami	208 hemipelvis	CMOR detected in 12% of Austrian population; emphasized surgical caution
Jensen KO et al. (2015)	Retrospective study on CMOR incidence and surgical relevance	130 consecutive patients	CMOR in 41.5% of cases; no significant correlation with hemorrhage complications or mortality
Jason CS (2009)	Determine CT detection rate of CMOR in pelvic trauma patients	50 patients (100 hemipelves)	CMOR detected in ~29% of patients using thin CT slices; emphasized CT utility for surgical planning

MATERIALS AND METHODS

The study was divided into 3 separate sections. Subjects were included from the **Department of Orthopaedics** (minimum 25 patients who underwent ORIF pelvis via anterior approach), **Department of Radiology** (150 consecutive CT angiographies) and **Department of Anatomy** (16 cadaveric hemi-pelvis).

Study Duration- 1st February 2022 till 31st August 2023

Calculation of Incidence Rate- In established literature, Incidence rate is calculated according to hemi-pelvis hence the cases in this study were noted on the basis of hemi-pelvis observed.

Surgical Assessment- 29 cases (43 hemi-pelvis observed)

As per surgical trend in previous years, a minimum of 25 patients were to be included in this study. However, 29 patients were admitted in department of Orthopaedics from 1st February 2022 till 31st August 2023 with injuries to pelvic ring with resultant instability with or without associated fracture of anterior column or wall of acetabulum who required Open Reduction and Internal Fixation through anterior approach to pelvis. Ilioinguinal approach or Modified Stoppa's approach was used and included in the study.

Intra-op Assessment: The cases operated included exposure of unilateral or bilateral superior pubic rami depending on the morphology of fracture and data was taken in form of hemi-pelvis observed for a total of 43 hemi-pelvis (15 unilateral and 14 bilateral cases). Intra-operative assessment was done after skin, soft tissue dissection and during

exposure of superior pubic rami. The surgeon dissected the area as per standard protocol and vessels if present were identified over the superior pubic rami. Further measurement was taken from pubic symphysis using flexible ruler and distance was noted. E.g. in picture 7 and 8.

Midline- Under C-arm observation, midline of pelvis was marked after aligning pubic symphysis in line with center of sacral spine.

Approaches used- Modified Stoppa's approach- With patient in supine position, incision is either vertical midline (over line marked from umbilicus to pubic symphysis) or Pfannenstiel incision marked just above pubic symphysis, deep dissection is done and rectus fascia is incised in longitudinal manner and insertion of rectus abdominis muscle is partly lifted from the pubic rami followed by careful dissection of superior pubic rami and CMOR if present is identified and ligated, dissection is continued subperiosteally and extended further laterally till entire superior pubic rami and quadrilateral plate are visible and obturator internus is lifted for better visualization. For additional exposure, a lateral window is made starting with incision given over the iliac crest beginning from behind the gluteus medius pillar extending towards midline, this window provides access to complete iliac fossa till anterior part of ipsilateral SI joint and helps in placement of implant.

Ilio-inguinal approach- This approach provides access to anterior acetabulum through formation of 3 windows for reduction and implant placement. With the patient lying supine a curved incision is given starting from posterior aspect of gluteus medius pillar and extended till approximately 2 cm past the midline over the pubic symphysis. External oblique muscle insertion over the iliac crest is released and iliac fossa is exposed after subperiosteal release of iliacus muscle. Further the external oblique aponeurosis is incised from anterior superior iliac spine till the

rectus abdominis muscle which is attached over the pubic crest. CMOR if present is encountered during dissection of the superior pubic rami and is identified and ligated. Lateral femoral cutaneous nerve and ilioinguinal nerve are encountered during this step and are protected. The final step involves identification and release of iliopectineal fascia after carefully retracting the external iliac vessels towards medial side. The 3 windows are now developed- Medial Window which is present medial to external iliac vessels till pubic symphysis, Middle Window between external iliac vessels and iliopsoas muscle and Lateral Window present lateral to iliopsoas. These provide access to pelvis extending from superior pubic rami till anterior part of ipsilateral SI joint.

Radiological Assessment- 150 Consecutive CTA(300 hemi-pelvis)

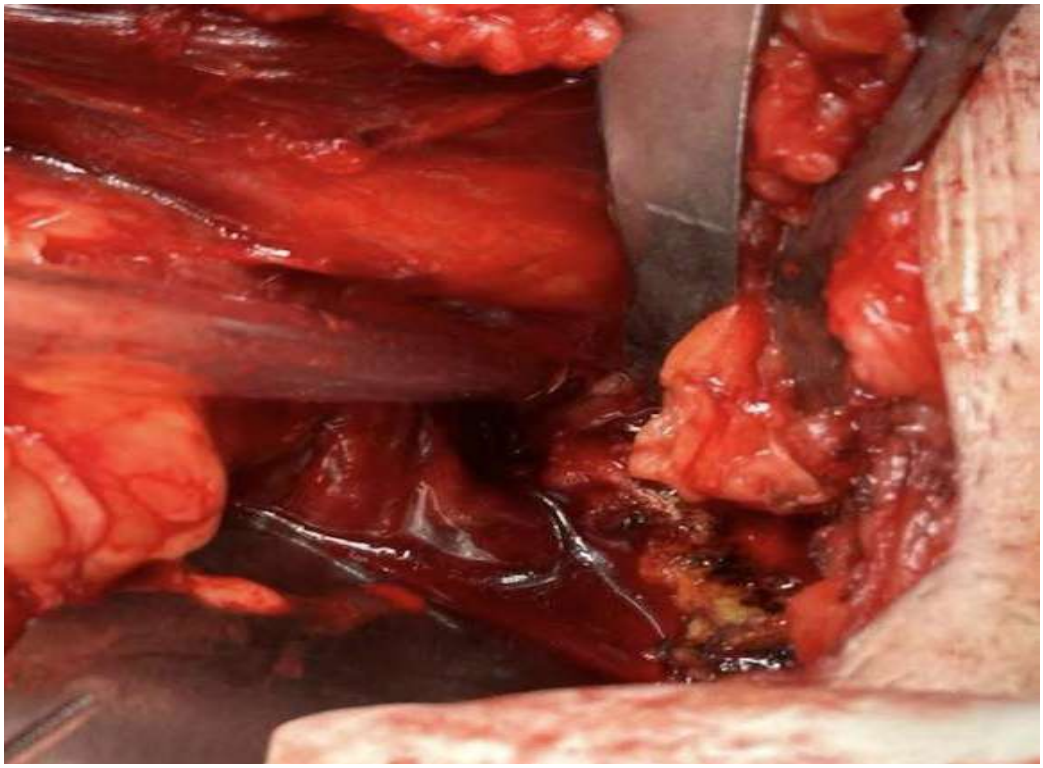
A study involving 150 patients for a total of 300 hemi-pelvis observed, who underwent Contrast Enhanced CT scan of lower abdomen or bilateral lower limbs were assessed within the study period to observe the incidence and distance of anastomosis from pubic symphysis. Using software of radiology department 2 points were marked starting from pubic symphysis till the vessel location in coronal sections and the resultant distance was noted. CT machine of Siemens company was used, with model Somatom Force, with 384 slices cut, and contrast used was Iomeron 350 mg for angiography given as IV bolus in 100ml normal saline given over a duration of 30 seconds using an injector and CT scan is performed within few minutes. Prior to contrast infusion creatinine value of patient is evaluated or in emergency cases informed high risk consent was taken from patient and attendants prior to contrast infusion. E.g. in picture 5 and 6.

Anatomical Assessment- 16 cadaveric hemi-pelvis dissection

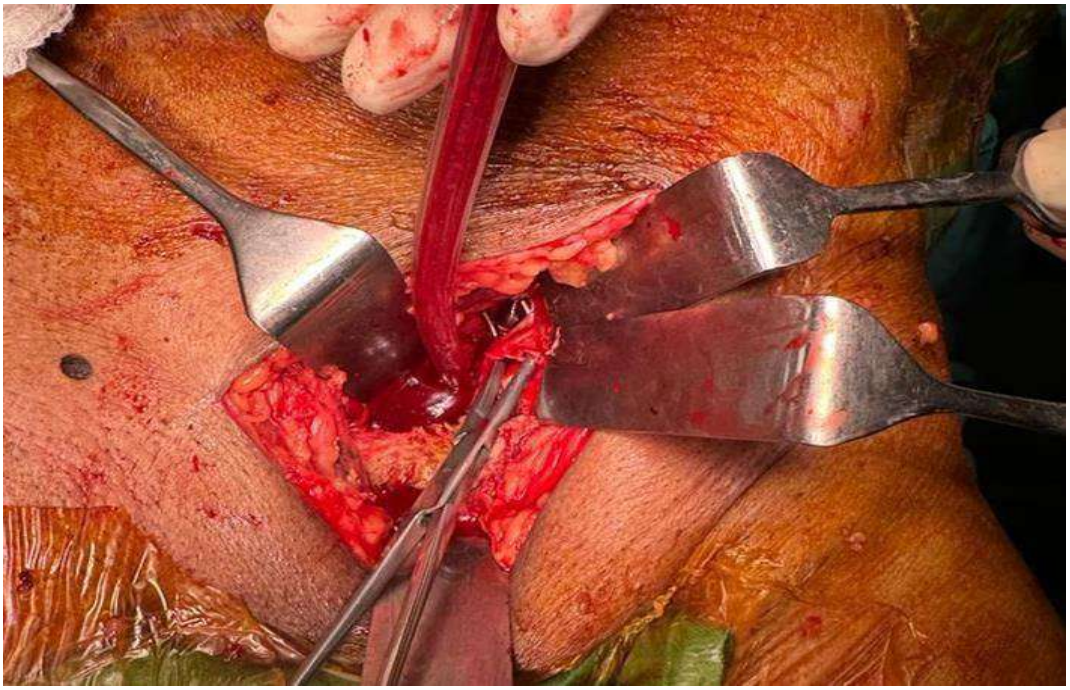
16 cadaveric hemi-pelvis were dissected in the department of Anatomy. This dissection aimed to locate and record the site and distance of the Corona Mortis anastomosis from the pubic symphysis. Dissection of pelvis was done and superior pubic rami was exposed and vessel if found immediately overlying the rami was identified and dissected carefully to identify the origin. Measurement of distance from pubic anastomosis was done using measuring tape and noted. E.g. in picture 3 and 4.

Statistical Analysis:

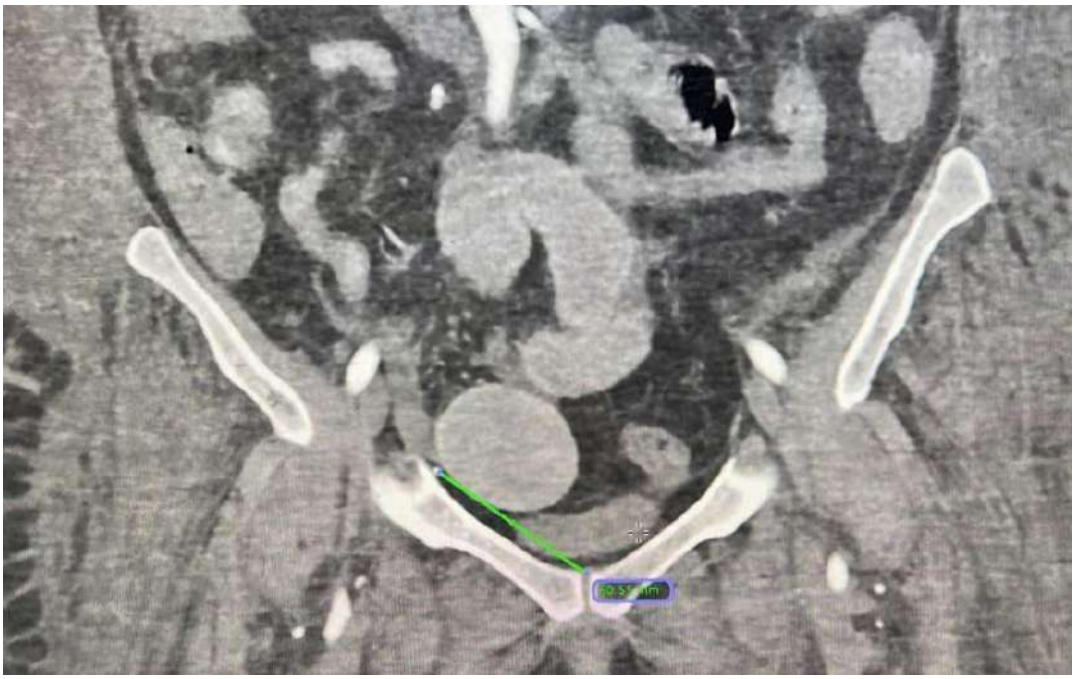
Data were described in terms of range; mean ±standard deviation (± SD), and frequencies (number of cases) and relative frequencies (percentages) as appropriate. To determine whether the data was normally distributed, a Kolmogorov-Smirnov test was used. Comparison of quantitative variables between the study groups was done using Mann Whitney U test and Kruskal-Wallis Test for non-parametric data. Comparison of quantitative variables was done using Wilcoxon rank test. For comparing categorical data, Chi square ($\chi 2$) test was performed, and fisher exact test was used when the expected frequency is less than 5. A probability value (p value) less than 0.05 was considered statistically significant. All statistical calculations were done using (Statistical Package for the Social Science) SPSS 26.0 version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.



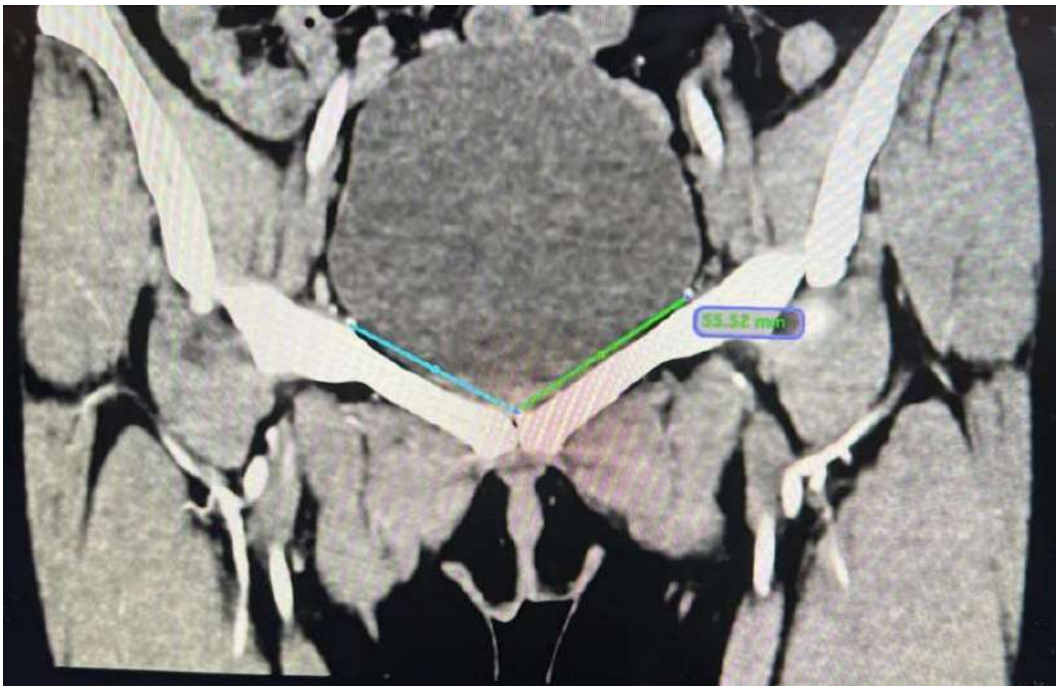
Picture 3: Intraoperative



Picture 4: Intraoperative



Picture 5: Radiological CTA



Picture 6: Radiological CTA

Picture 7: Cadaveric specimen

Picture 8: Cadaveric specimen

OBSERVATIONS AND RESULTS

CADAVERIC DATA

Table 1: Distribution of cadavers according to gender

	Cadaver	
GENDER	**Frequency**	**Percent**
MALE	16	100
FEMALE	0	0
TOTAL	16	100

All cadavers examined were male (100%). This indicates a lack of female cadaveric data which may limit the generalizability of the findings to the male population only.

Figure 1: Distribution of cadavers according to gender

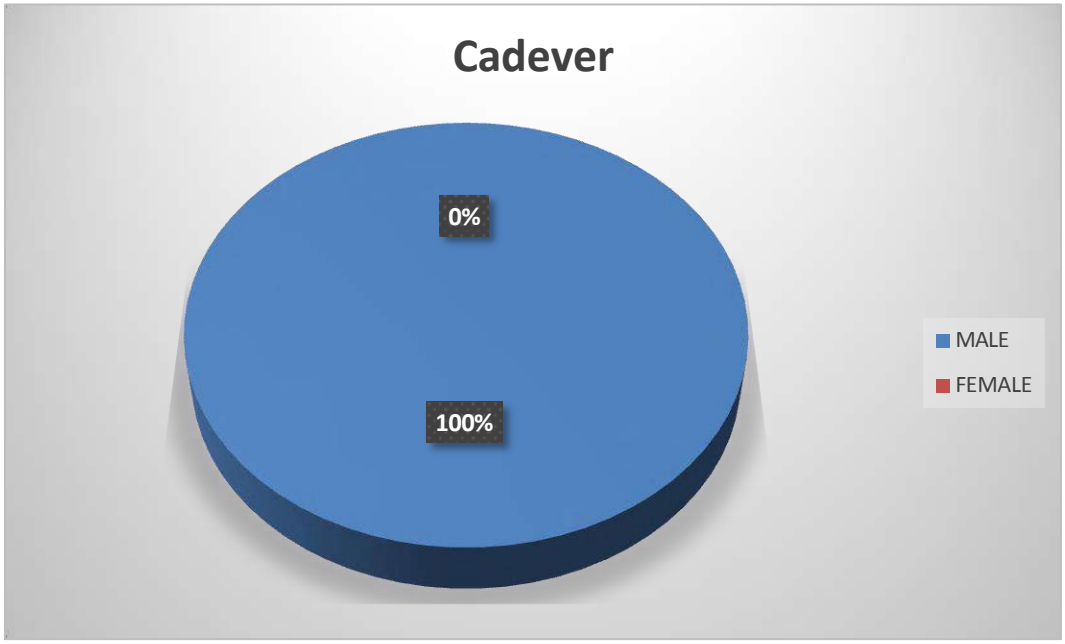


Table 2: Distribution of cadavers according to incidence of corona mortis

INCIDENCE	Frequency	Percent
ABSENT	6	37.5
PRESENT	10	62.5
Total	16	100

Corona mortis was present in 62.5% of the cadavers, suggesting that this anatomical variation is relatively common. Its absence in 37.5% of cases shows variability in its occurrence.

Figure 2: Distribution of cadavers according to incidence of corona mortis

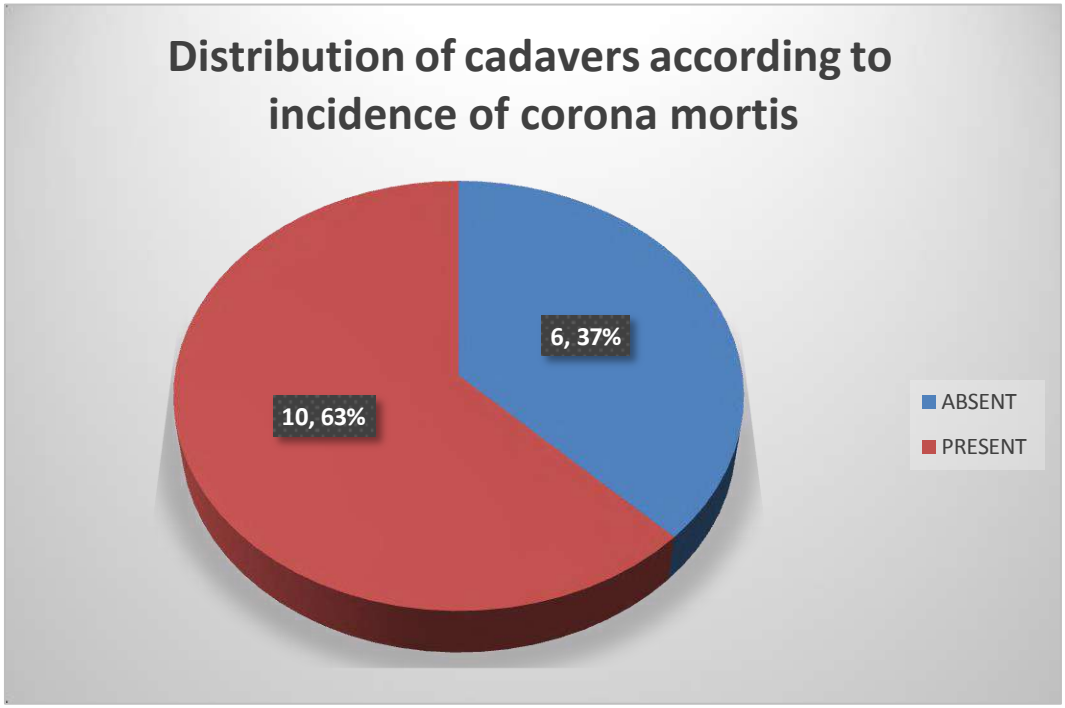


Table 3: Distribution of corona mortis in cadavers according to laterality

LATERALITY	Frequency	Percent
LEFT	5	50
RIGHT	5	50
Total	10	100

Among the cadavers with corona mortis, it was evenly distributed between the left (50%) and right (50%) sides, indicating no lateral dominance in its presence.

Figure 3: Distribution of corona mortis in cadavers according to laterality

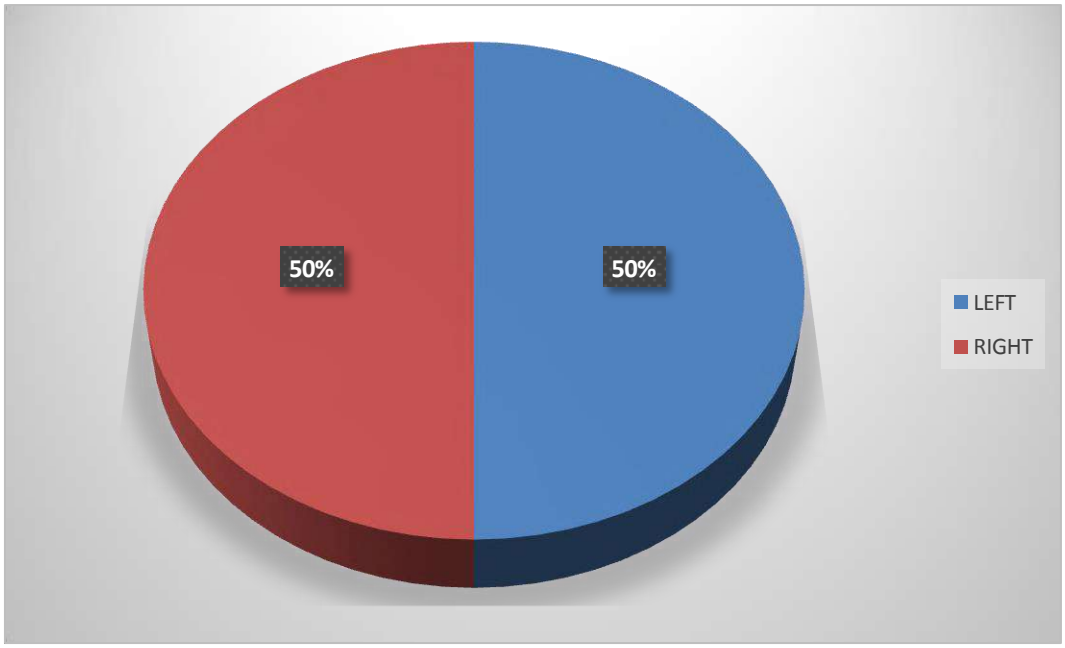
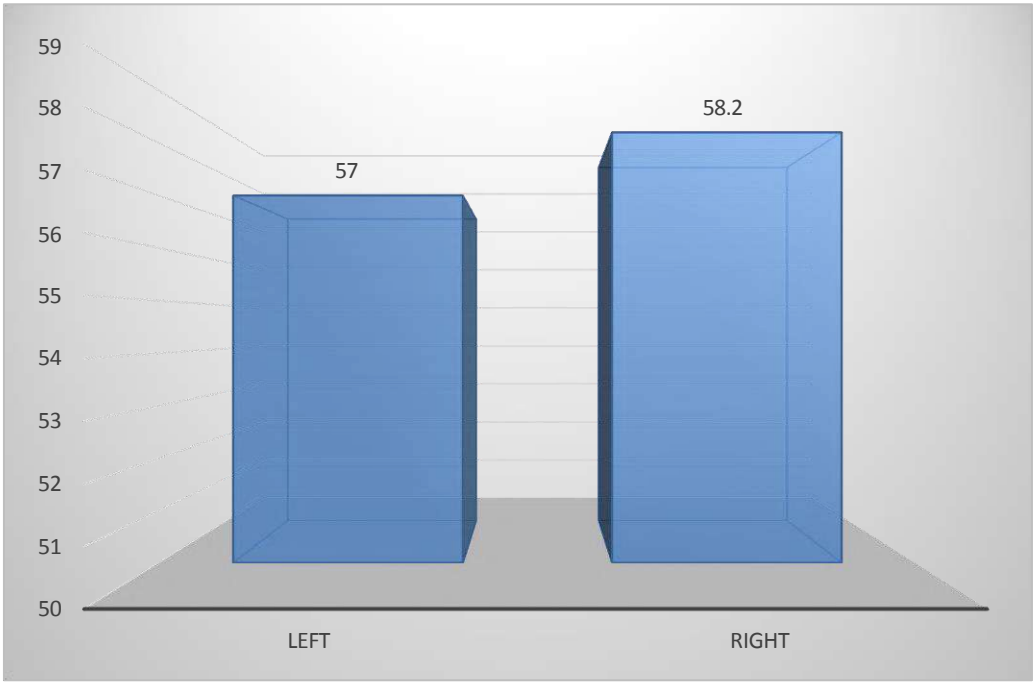


Table 4: Mean distance comparison of right and left side of corona mortis in cadavers

	N	Mean distance	Std. Deviation	Mann-Whitney U	P-value
LEFT	5	57	7.874	14.5	0.671
RIGHT	5	58.2	6.38		

The mean distance of corona mortis on the left side was 57 mm with a standard deviation of 7.874 mm. The mean distance on the right side was 58.2 mm with a standard deviation of 6.38 mm. The Mann-Whitney U test yielded a p-value of 0.671, indicating no significant difference between the mean distances on the left and right sides.

Figure 4: Mean distance comparison of right and left side of corona mortis in cadavers



SURGICAL CASES

Table 5: Distribution of surgical cases according to gender

Gender	Frequency	Percent
Female	12	41.4
Male	17	58.6
total	29	100.0

The table 5 shows that out of 29 surgical cases, 12 were female (41.4%) and 17 were male (58.6%). This indicates a higher proportion of male patients in the surgical cases studied.

Figure 5: Distribution of surgical cases according to gender

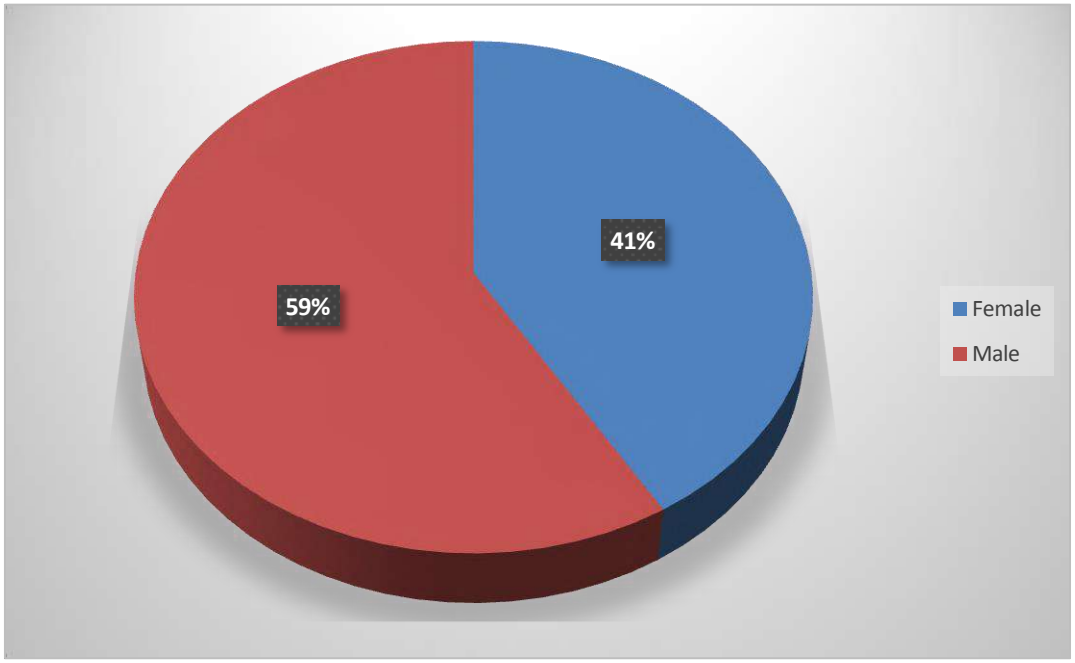


Table 6: Distribution of surgical cases according to religion

	Frequency	Percent
Hindu	13	44.8
Sikh	16	55.2
Total	29	100.0

This table 6 presents the religious distribution of the surgical cases, with 13 patients (44.8%) identifying as Hindu and 16 patients (55.2%) identifying as Sikh. The majority of the cases were from the Sikh community.

Figure 6: Distribution of surgical cases according to religion

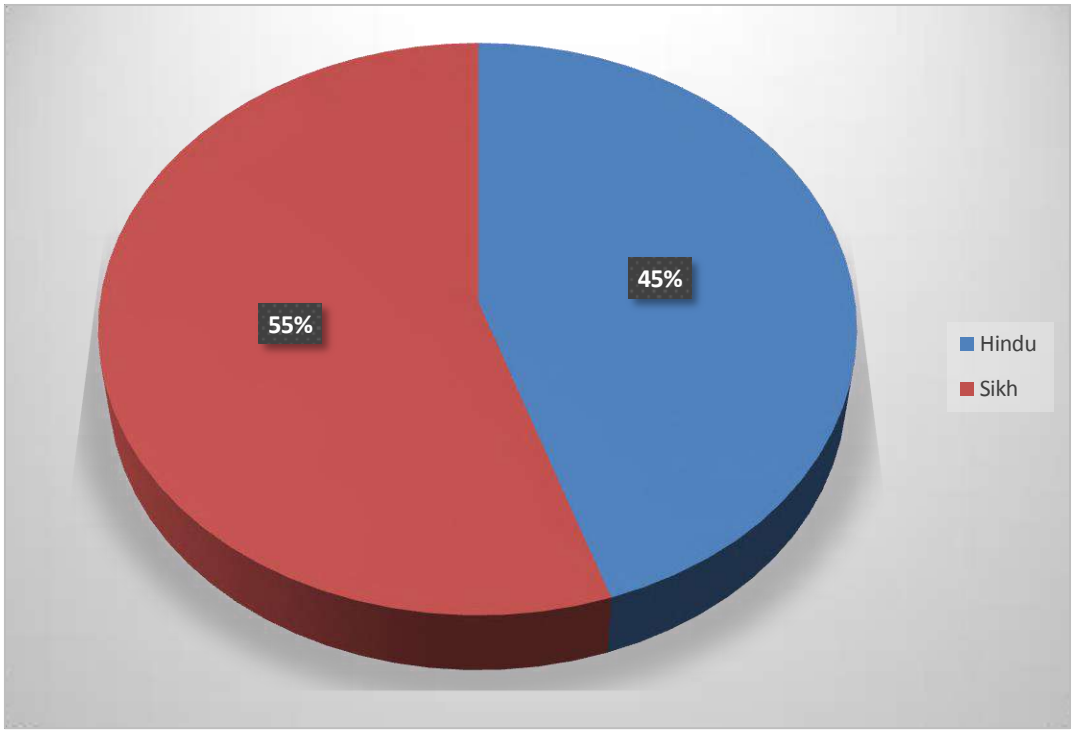


Table 7: Distribution of surgical cases according to approach used

Approach	Frequency	Percent
IL	7	24.1
MS	22	75.9
Total	29	100.0

The table 7 details the surgical approach used in the cases. IL (Ilioinguinal) was used in 7 cases (24.1%), while MS (Modified Stoppa's) was used in 22 cases (75.9%). MS was the predominant approach used in these surgeries.

Figure 7: Distribution of surgical cases according to approach used

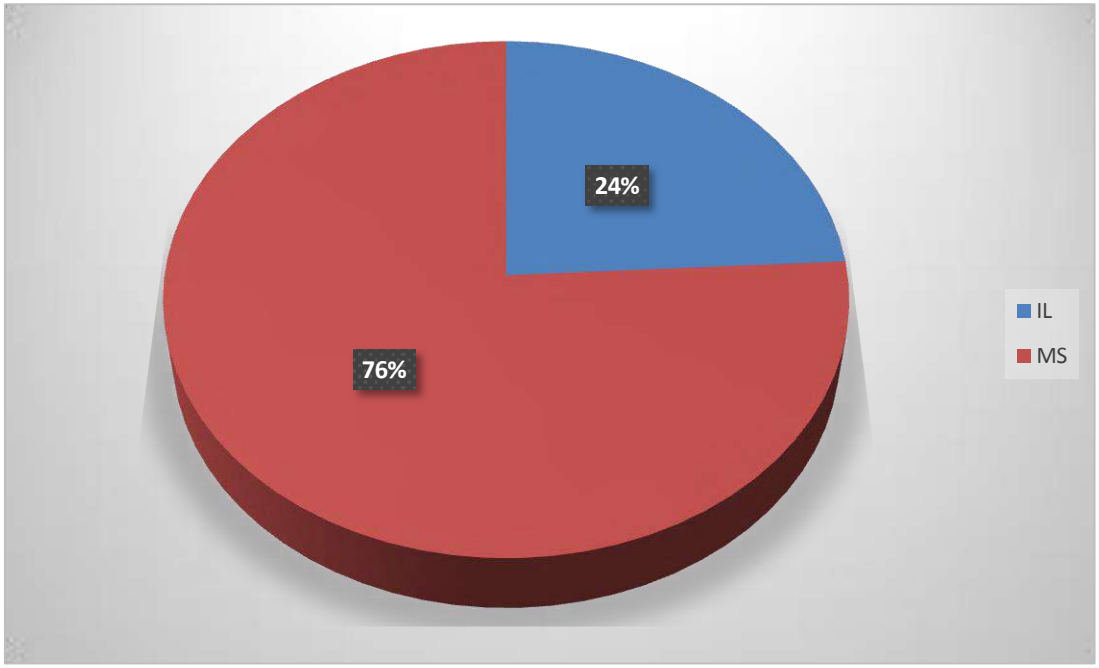


Table 8: Distribution of surgical cases according to side exposed

Laterality	Cases	Total hemi-pelvis
Unilateral	15	15
Bilateral	14	28
Total	29	43

The table 8 details the type of exposure of superior pubic rami. Unilateral exposures were done in 15 patients and 15 hemi-pelvis were observed. Bilateral exposure was done in 14 patients hence 28 hemi-pelvis were observed. A total number of 43 hemi-pelvis were observed in 29 patients.

Figure 8: Distribution of surgical cases according to side exposed

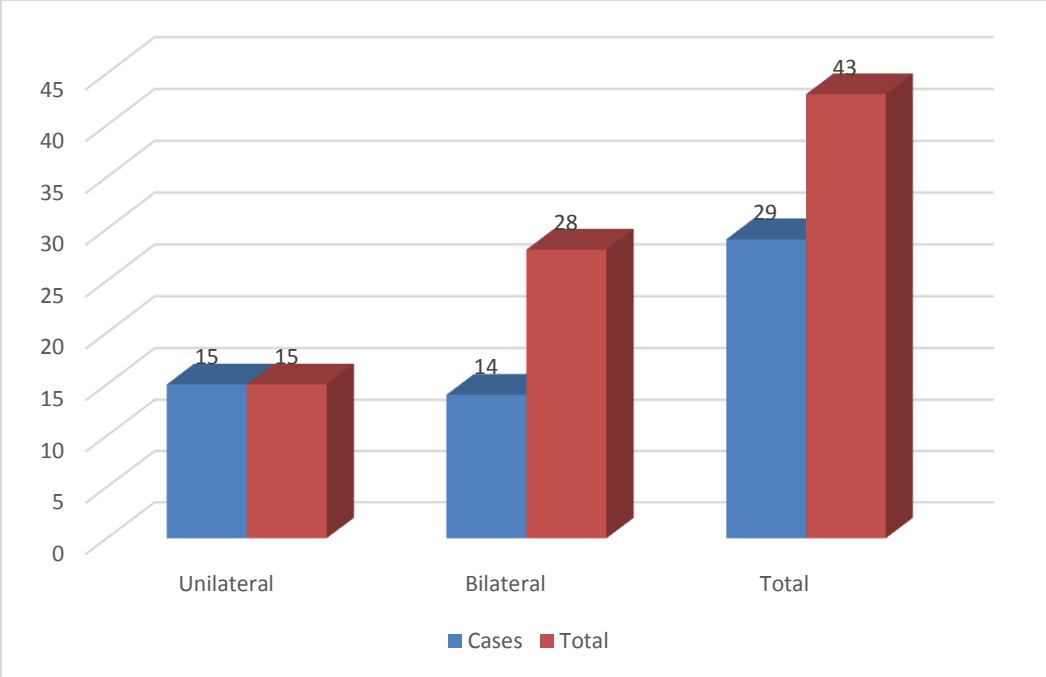


Table 9: Distribution of surgical cases according to incidence of corona mortis

	Frequency	Percent
absent	20	69
present	9	31
Total	29	100.0

This table 9 shows that corona mortis was absent in 20 cases (69%) and present in 9 cases (31%). The majority of the surgical cases did not exhibit corona mortis.

Figure 9: Distribution of surgical cases according to incidence of corona mortis

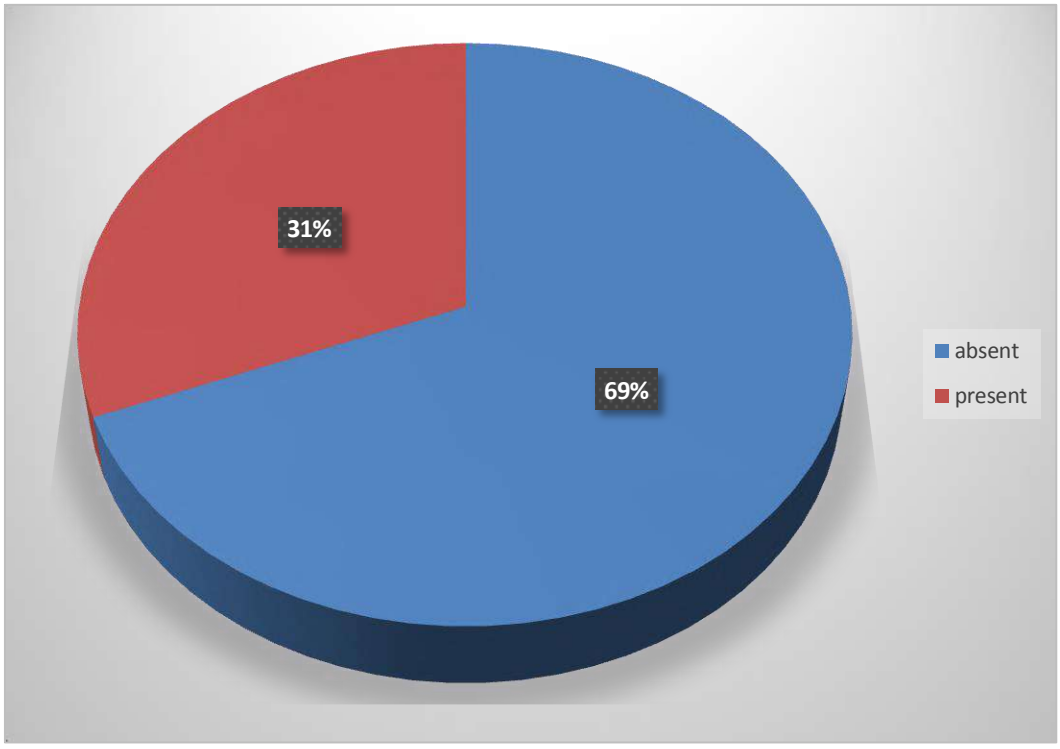


Table 10: Distribution of surgical cases laterality of corona mortis

	Frequency	Percent
Absent	20	69.0
Bilateral	2	6.9
Left	4	13.8
Right	3	10.3
Total	29	100.0

The table 10 reveals that corona mortis was absent in 20 cases (69%), bilateral in 2 cases (6.9%), left-sided in 4 cases (13.8%), and right-sided in 3 cases (10.3%). Most cases did not show corona mortis, but when present, it was more frequently on the left side.

Figure 10: Distribution of surgical cases laterality of corona mortis

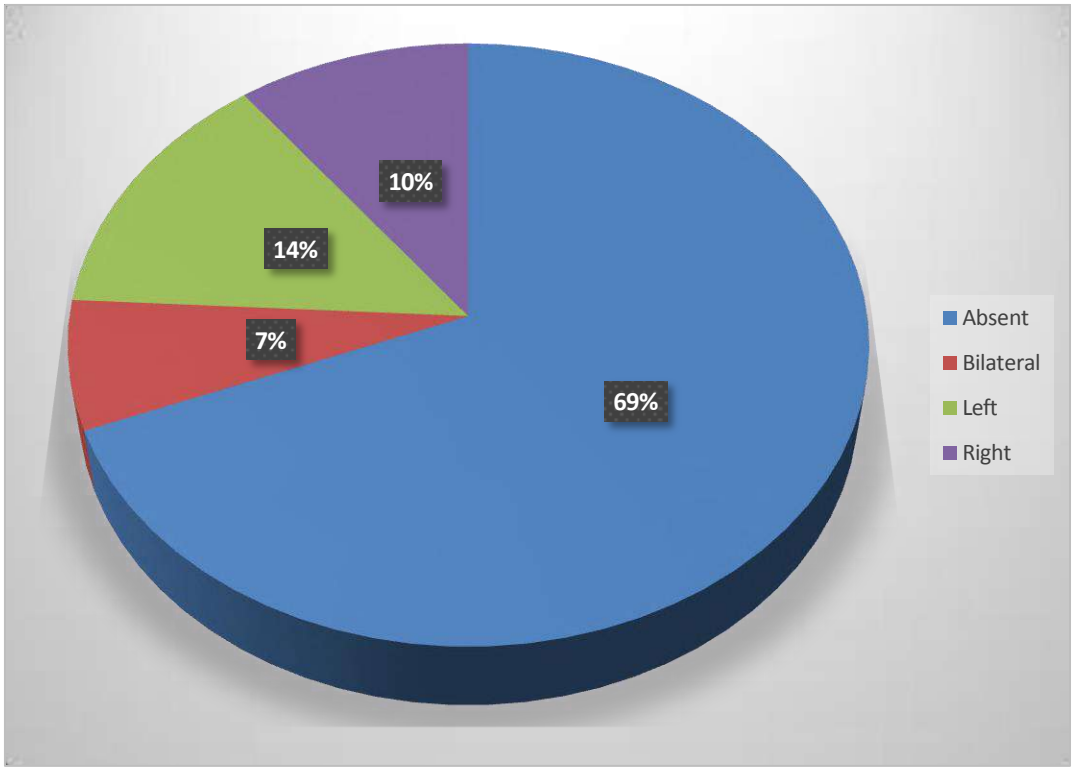


Table 11: Incidence rate of corona mortis as per hemipelvis observed during surgery

	Frequency	Percent
absent	31	72.1
present	12	27.9
Total	43	100.0

Out of 43 hemipelvis observed, corona mortis was absent in 31 (72.1%) and present in 12 (27.9%).

Figure 11: Incidence rate of corona mortis as per hemipelvis observed during surgery

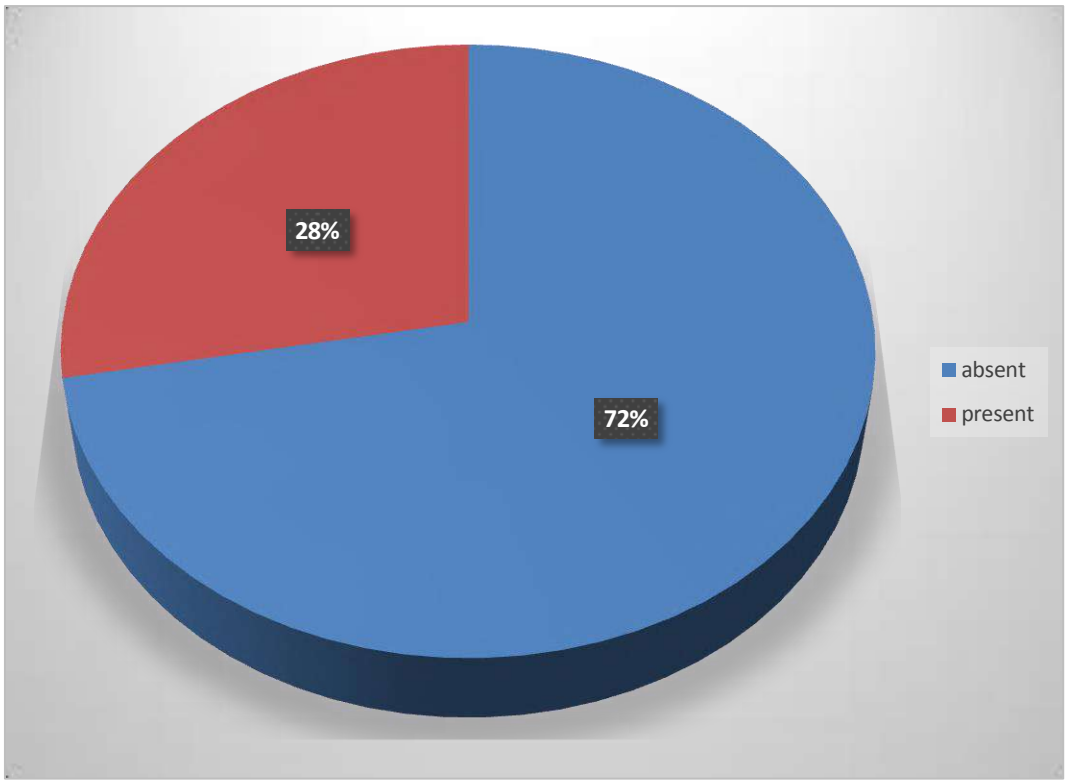


Table 12: Distribution of patients of corona mortis as per hemipelvis observed during surgery according to side

	Frequency	Percent
Absent	31	72.1%
left	6	14.0%
right	6	14.0%
Total	43	100.0%

Out of 43 hemipelvis observed, corona mortis was absent in 31 (72.1%) and present in 12 (27.9%). Additionally, the data indicates that corona mortis was found on the left side in 6 cases (14.0%) and on the right side in another 6 cases (14.0%).

Figure 12: Distribution of patients of corona mortis as per hemipelvis observed during surgery according to side

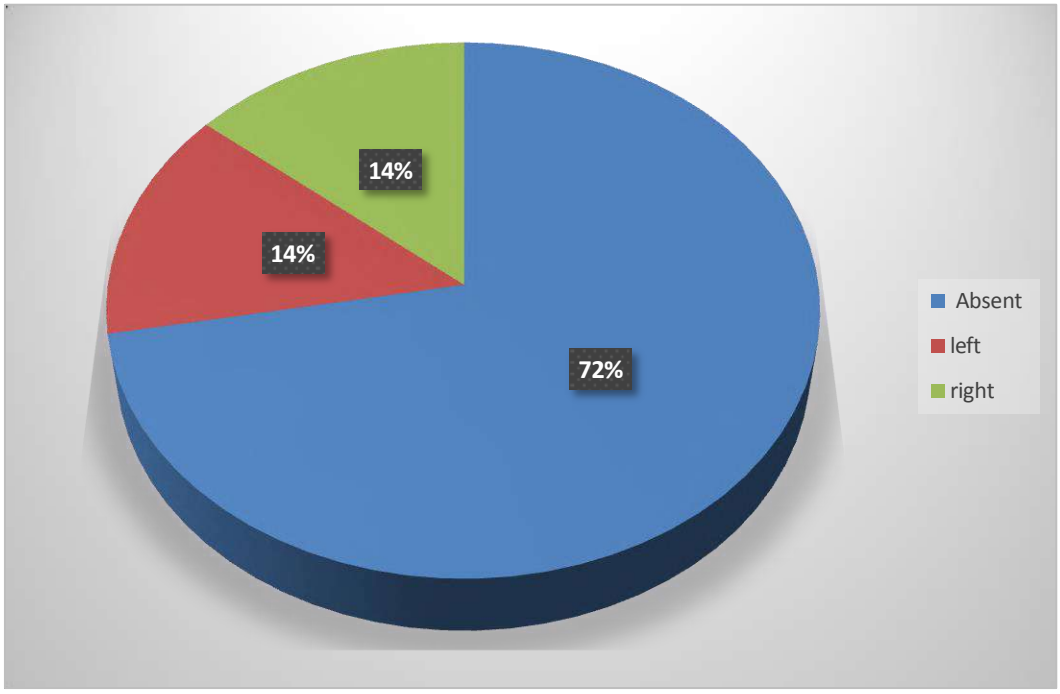


Table 13: Association of gender with the presence of corona mortis in surgical cases

Presence	gender						chi-square	p-value
	Female		Male		Total			
	n	%	N	%	n	%		
absent	10	83.30%	10	58.80%	20	69.00%	1.97[a]	0.16
present	2	16.70%	7	41.20%	9	31.00%		
Total	12	100.00%	17	100.00%	29	100.00%		

The table 13 details the laterality of corona mortis in relation to gender. Among females, 10 (83.3%) had no corona mortis, 1 (8.3%) had bilateral, and 1 (8.3%) had left-sided. Among males, 10 (58.8%) had no corona mortis, 1 (5.9%) had bilateral, 3 (17.6%) had left-sided, and 3 (17.6%) had right-sided. The chi-square value is 3.23 with a p-value of 0.357, indicating no significant association.

Figure 13: Association of gender with the presence of corona mortis in surgical cases

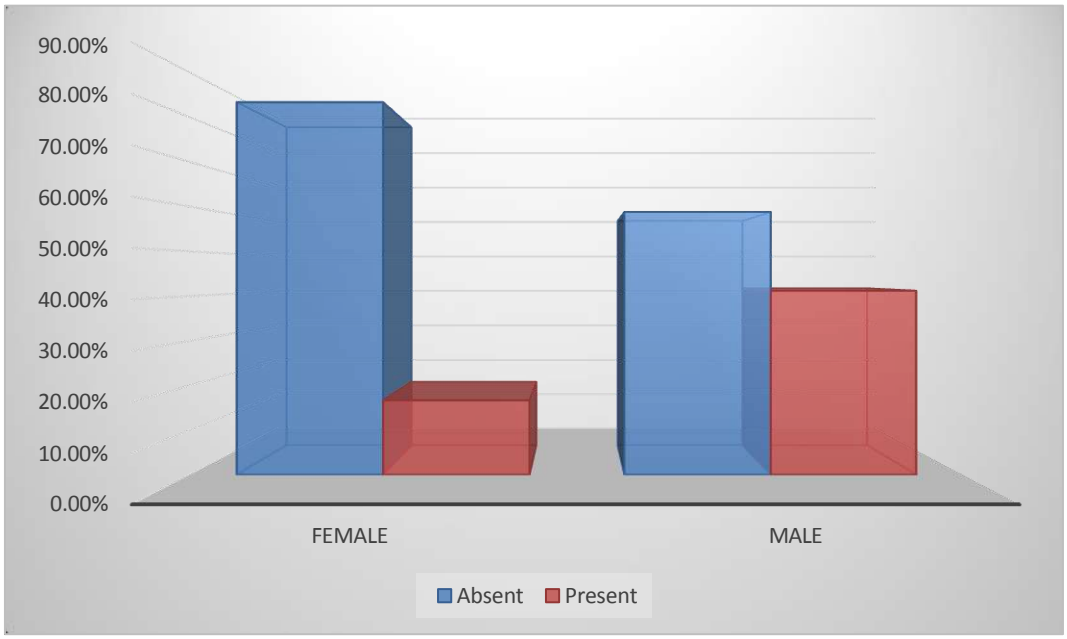


Table 14: Association of gender with laterality of corona mortis in surgical cases

	Gender						chi-square	p-value
	Female		Male		Total			
	N	%	n	%	n	%		
Absent	10	83.3%	10	58.8%	20	69.0%	3.23	0.357
Bilateral	1	8.3%	1	5.9%	2	6.9%		
Left	1	8.3%	3	17.6%	4	13.8%		
Right	0	0.0%	3	17.6%	3	10.3%		
Total	12	100.0%	17	100.0%	29	100.0%		

The table 14 shows the presence of corona mortis by religion. Among Hindus, 10 (76.9%) had no corona mortis, and 3 (23.1%) did. Among Sikhs, 10 (62.5%) had no corona mortis, and 6 (37.5%) did. The chi-square value is 0.69 with a p-value of 0.45, showing no significant association between religion and the presence of corona mortis.

Figure 14: Association of gender with laterality of corona mortis in surgical cases

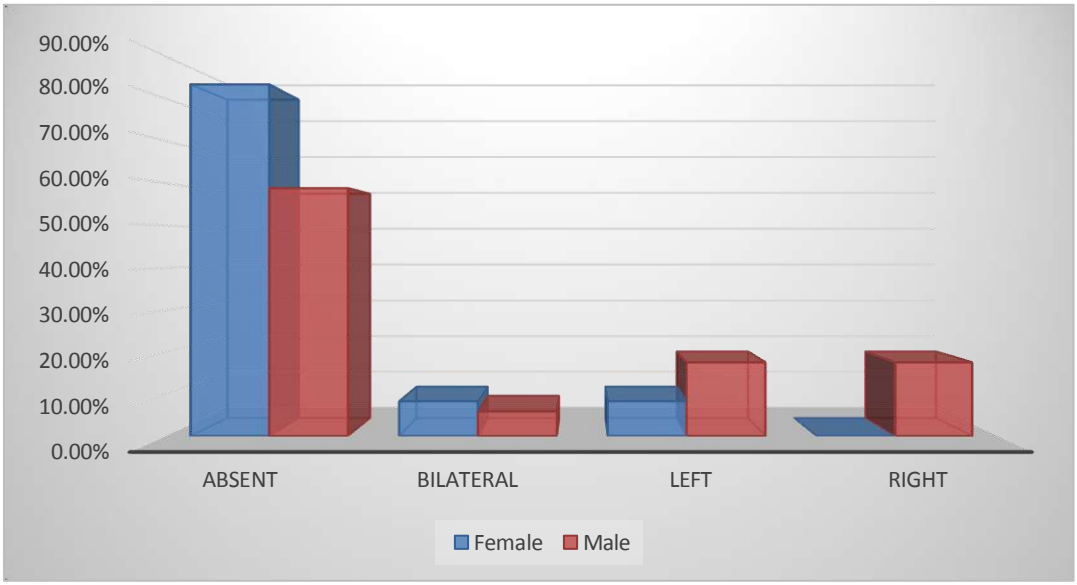


Table 15: Association of religion with presence of corona mortis in surgical cases

Presence	Religion						chi-square	p-value
	Hindu		Sikh		Total			
	n	%	n	%	n	%		
absent	10	76.9%	10	62.5%	20	69.0%	0.69	0.45
present	3	23.1%	6	37.5%	9	31.0%		
Total	13	100.0%	16	100.0%	29	100.0%		

The table 15 presents the laterality of corona mortis by religion. Among Hindus, 10 (76.9%) had no corona mortis, 1 (7.7%) had bilateral, 1 (7.7%) had left-sided, and 1 (7.7%) had right-sided. Among Sikhs, 10 (62.5%) had no corona mortis, 1 (6.3%) had bilateral, 3 (18.8%) had left-sided, and 2 (12.5%) had right-sided. The chi-square value is 1.09 with a p-value of 0.79, indicating no significant association.

Figure 15: Association of religion with presence of corona mortis in surgical cases

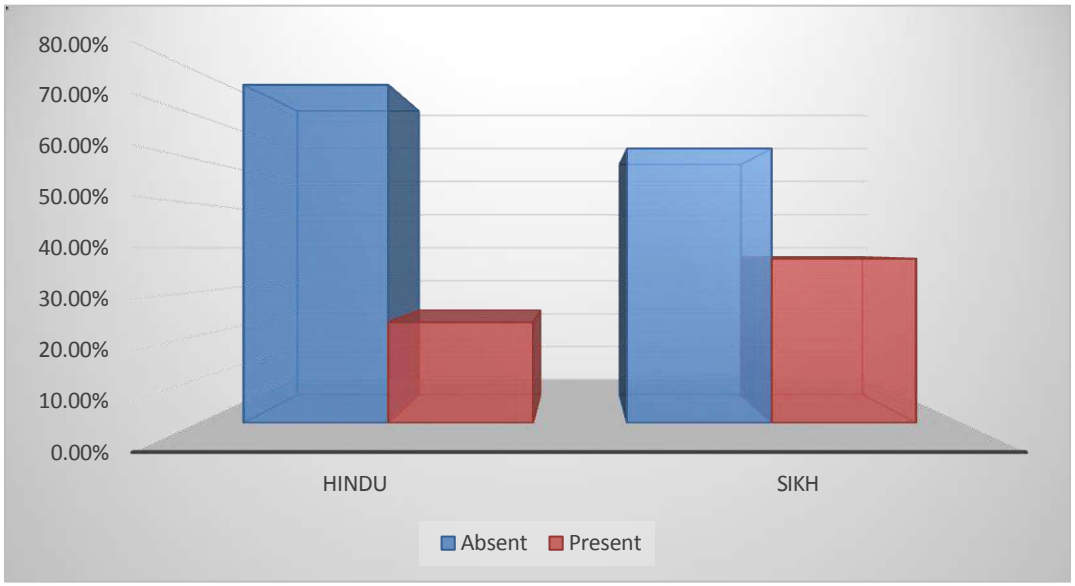


Table 16: Association of religion with laterality of corona mortis in surgical cases

	Religion						chi-square	p-value
	Hindu		Sikh		Total			
	N	%	N	%	n	%		
Absent	10	76.9%	10	62.5%	20	69.0%	1.09	0.79
Bilateral	1	7.7%	1	6.3%	2	6.9%		
Left	1	7.7%	3	18.8%	4	13.8%		
Right	1	7.7%	2	12.5%	3	10.3%		
Total	13	100.0%	16	100.0%	29	100.0%		

The table 16 presents the laterality of corona mortis by religion. Among Hindus, 10 (76.9%) had no corona mortis, 1 (7.7%) had bilateral, 1 (7.7%) had left-sided, and 1 (7.7%) had right-sided. Among Sikhs, 10 (62.5%) had no corona mortis, 1 (6.3%) had bilateral, 3 (18.8%) had left-sided, and 2 (12.5%) had right-sided. The chi-square value is 1.09 with a p-value of 0.79, indicating no significant association.

Figure 16: Association of religion with laterality of corona mortis in surgical cases

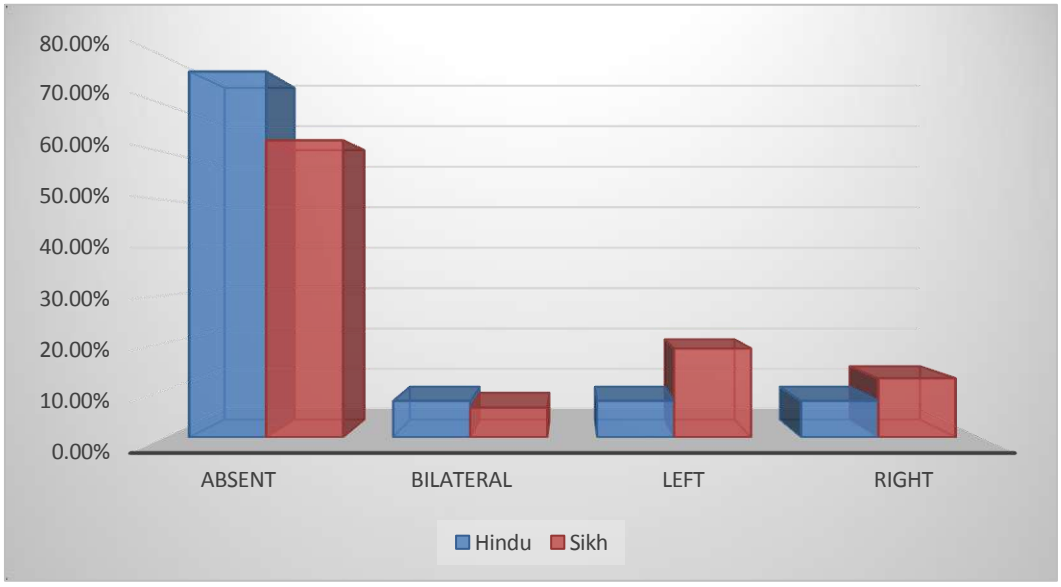


Table 17: Mean distance of corona mortis in surgical cases as per laterality

Laterality	N	Mean distance	Std. Deviation	Man Whitney (U)	p-value
Left	6	59.91	3.38	9.5	0.18
Right	6	58.26	1.98		

The table 17 shows the mean distance of corona mortis in surgical cases by side. For the left side, the mean distance was 59.91 cm with a standard deviation of 3.38 cm, and for the right side, the mean distance was 58.26 cm with a standard deviation of 1.98 cm. The Mann-Whitney U value is 9.5 with a p-value of 0.18, indicating no significant difference.

Figure 17: Mean distance of corona mortis in surgical cases as per laterality

Table 18: Comparison of a mean distance of corona mortis in surgical cases with respect to gender

GENDER	N	Mean distance	Std. Deviation	Man Whitney (U)	p-value
Male	9	58.90	3.0627	18	.48
Female	3	59.66	2.0817		

The table 18 compares the mean distance of corona mortis between genders. For males, the mean distance was 58.90 cm with a standard deviation of 3.06 cm, and for females, the mean distance was 59.67 cm with a standard deviation of 2.08 cm. The Mann-Whitney U value is 18 with a p-value of 0.48, showing no significant difference.

Figure 18: Comparison of a mean distance of corona mortis in surgical cases in left and right side with respect to gender

Table 19: Comparison of a mean distance of corona mortis in surgical cases in left and right side with respect to religion

Religion	N	Mean distance	Std. Deviation	Man Whitney (U)	p-value
Hindu	4	58.75	2.50	16	1
Sikh	8	59.26	3.06		

The table 19 compares the mean distance of corona mortis between religions. For Hindus, the mean distance was 58.75 cm with a standard deviation of 2.50 cm, and for Sikhs, the mean distance was 59.26 cm with a standard deviation of 3.06 cm. The Mann-Whitney U value is 16 with a p-value of 1, indicating no significant difference.

Figure 19: Comparison of a mean distance of corona mortis in surgical cases in left and right side with respect to religion

Radiological

300 hemipelvis's were considered for radiological examination

Table 20: Distribution of radiological cases according to gender

	Frequency	Percent
Male	144	48
Female	156	52
Total	300	100

The distribution of radiological cases by gender (Table 19) shows a nearly even split, with 48% male and 52% female.

Figure 20: Distribution of radiological cases according to gender

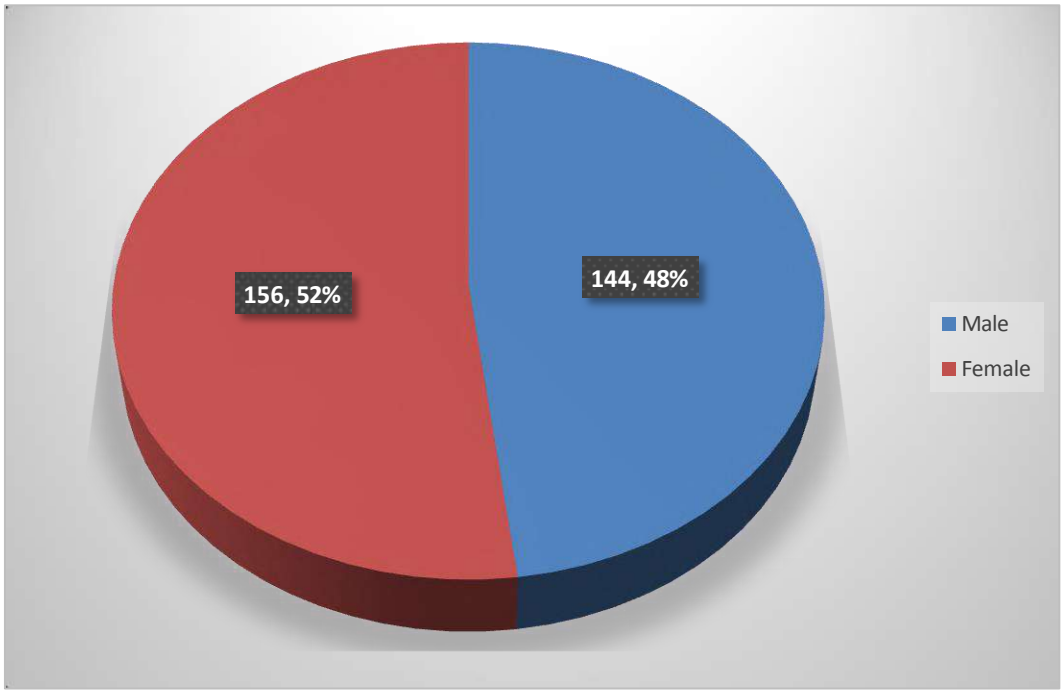


Table 21: Distribution of radiological cases according to religion

	Frequency	Percent
Hindu	138	46
Sikh	158	52.7
Muslim	2	0.7
Christian	2	0.7
Total	300	100

The distribution by religion (Table 21) indicates that the majority of patients are Sikh (52.7%) and Hindu (46%), with a very small representation of Muslims and Christians (0.7% each).

Figure 21: Distribution of radiological cases according to religion

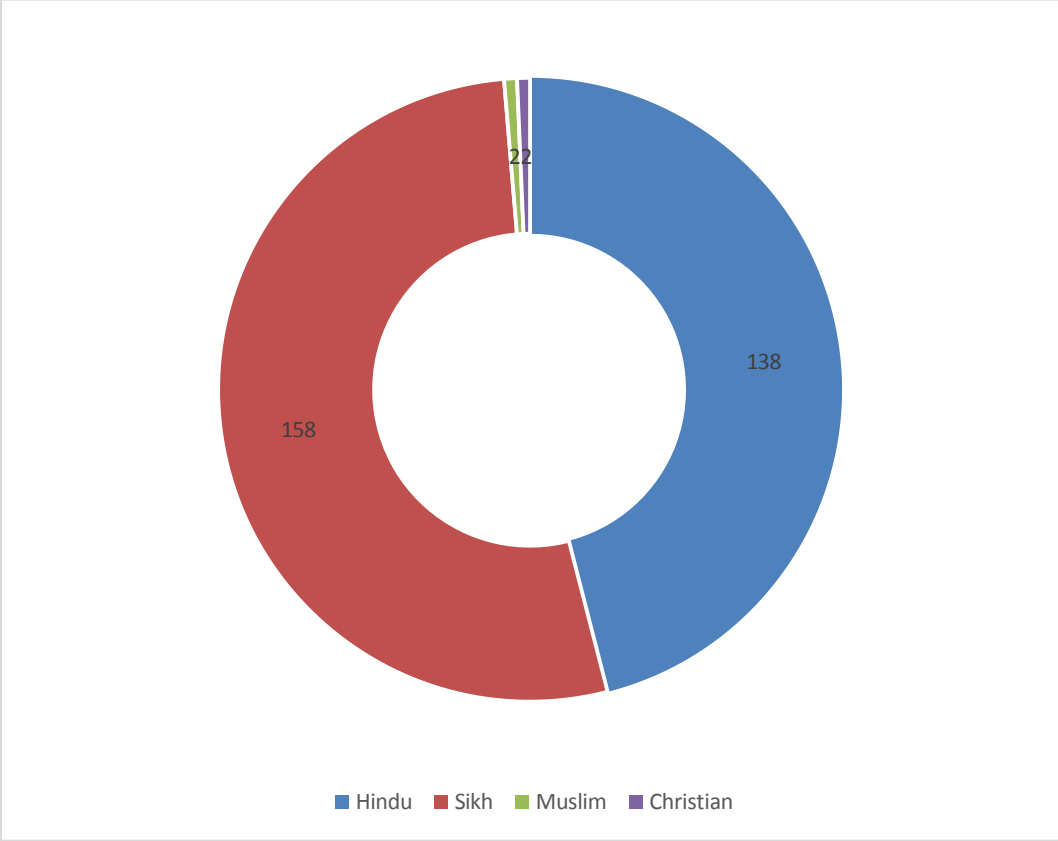


Table 22: Incidence of corona mortis among radiological cases

	Frequency	Percent
Absent	248	82.7
Present	52	17.3
Total	300	100.0

The incidence of corona mortis (Table 22) shows that it is absent in 82.7% of cases and present in 17.3%.

Figure 22: Incidence of corona mortis among radiological cases

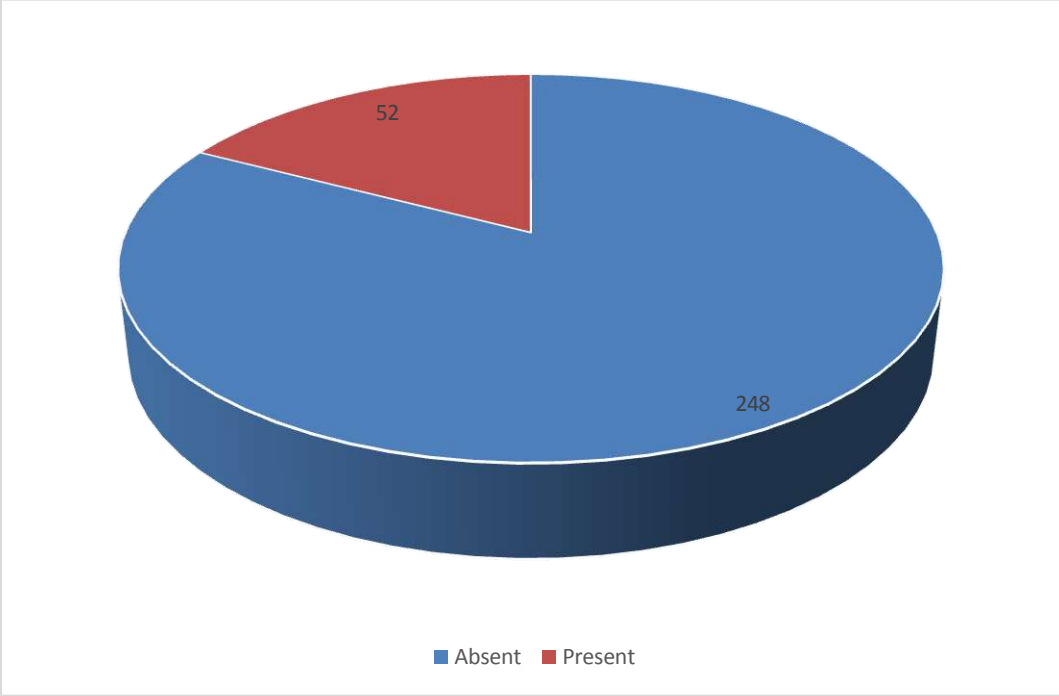


Table 23: Laterality of Corona Mortis among radiological cases

	Frequency	Percent
Absent	109	72.7
Left	17	11.3
Right	13	8.7
Bilateral	11	7.3
Total	150	100

Regarding the laterality of corona mortis (Table 23), it is absent in 72.7% of cases, present on the left side in 11.3%, on the right side in 8.7%, and bilaterally in 7.3%.

Figure 23: Laterality of Corona Mortis among radiological cases (Total)

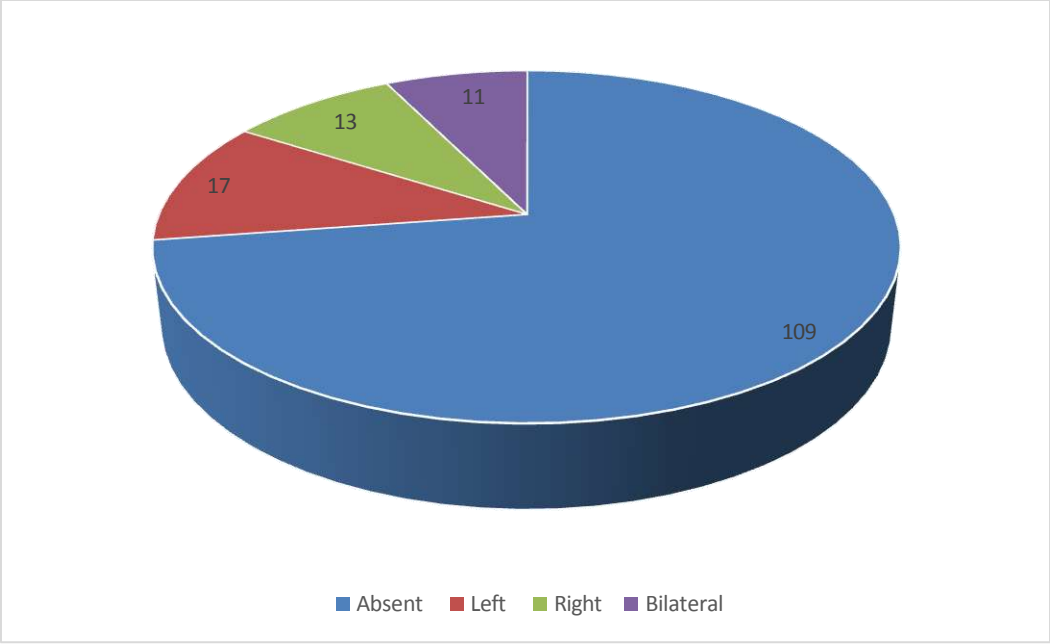


Table 24: Laterality of corona mortis among radiological cases (hemipelvis)

	Frequency	Percent
Absent	248	82.7
Left	28	9.3
Right	24	8.0
Total	300	100.0

Regarding the laterality of corona mortis (Table 24), it is absent in 82.7% of cases, present on the left side in 9.3%, on the right side in 8%.

Figure 24: Laterality of corona mortis among radiological cases

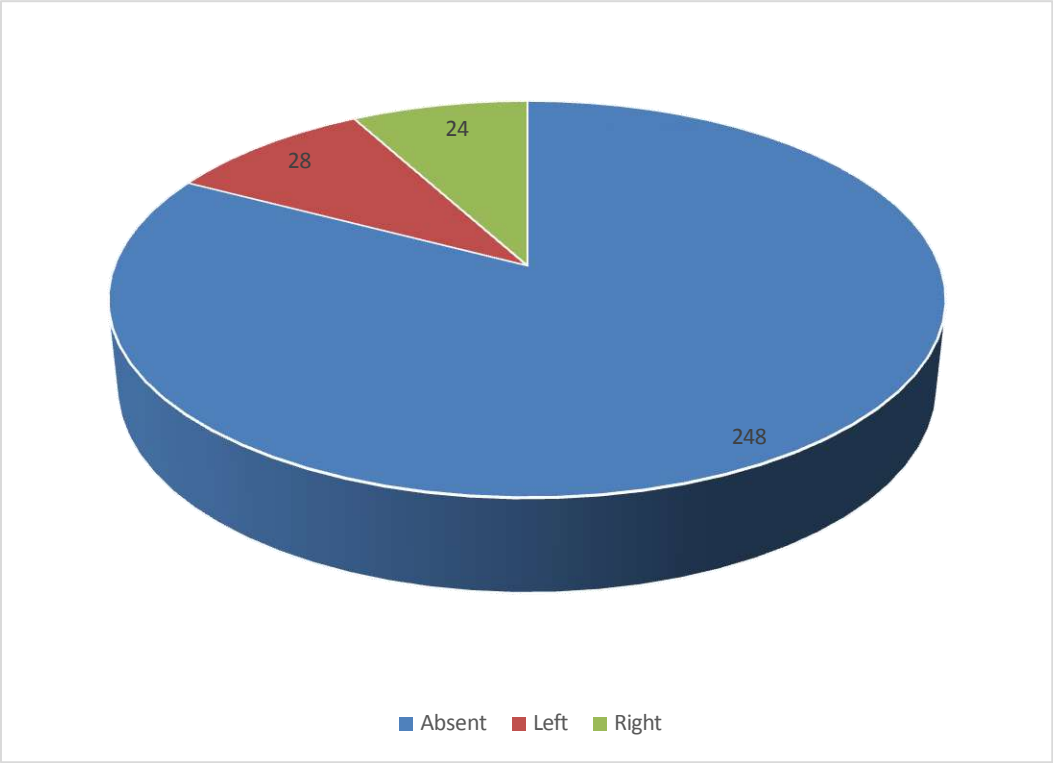


Table 25: Association of gender with a incidence of corona mortis among radiological cases

Presence	Gender						chi-square	p-value
	Male		Female		Total			
	n	%	n	%	N	%		
Absent	121	84.0%	127	81.4%	248	82.7%	0.35	0.55
Present	23	16.0%	29	18.6%	52	17.3%		
Total	144	100.0%	156	100.0%	300	100.0%		

The association of gender with the incidence of Corona Mortis among radiological cases is shown in Table 25. Among the 300 cases, 82.7% (248 cases) did not have Corona Mortis. Of these, 84.0% (121 cases) were male and 81.4% (127 cases) were female. For the 52 cases (17.3%) with Corona Mortis, 16.0% (23 cases) were male and 18.6% (29 cases) were female. The chi-square value of 0.35 and a p-value of 0.55 indicate no significant association between gender and the incidence of Corona Mortis.

Figure 25: Association of gender with a incidence of corona mortis among radiological cases

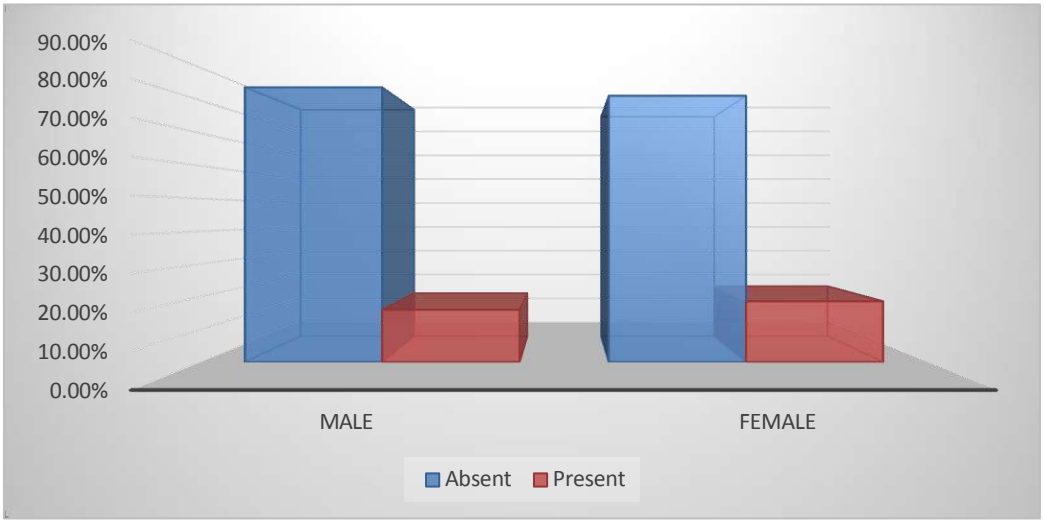


Table 26: Association of gender with distance of corona mortis with laterality in radiological cases

	Gender						chi-square	p-value
	Male		Female		Total			
	n	%	n	%	n	%		
Absent	121	84.0%	127	81.4%	248	82.7%	0.95	0.62
Left	11	7.6%	17	10.9%	28	9.3%		
Right	12	8.3%	12	7.7%	24	8.0%		
Total	144	100.0%	156	100.0%	300	100.0%		

Table 26 details the association of gender with the laterality of Corona Mortis in radiological cases. Out of 300 cases, 82.7% (248 cases) were absent of Corona Mortis. Among these, 84.0% (121 cases) were male and 81.4% (127 cases) were female. For those with Corona Mortis, 9.3% (28 cases) were left-sided (7.6% male, 10.9% female), and 8.0% (24 cases) were right (8.3% male, 7.7% female). The chi-square value of 0.95 and p-value of 0.62 suggest no significant association between gender and the laterality of Corona Mortis.

Figure 26: Association of gender with distance of corona mortis with laterality in radiological cases

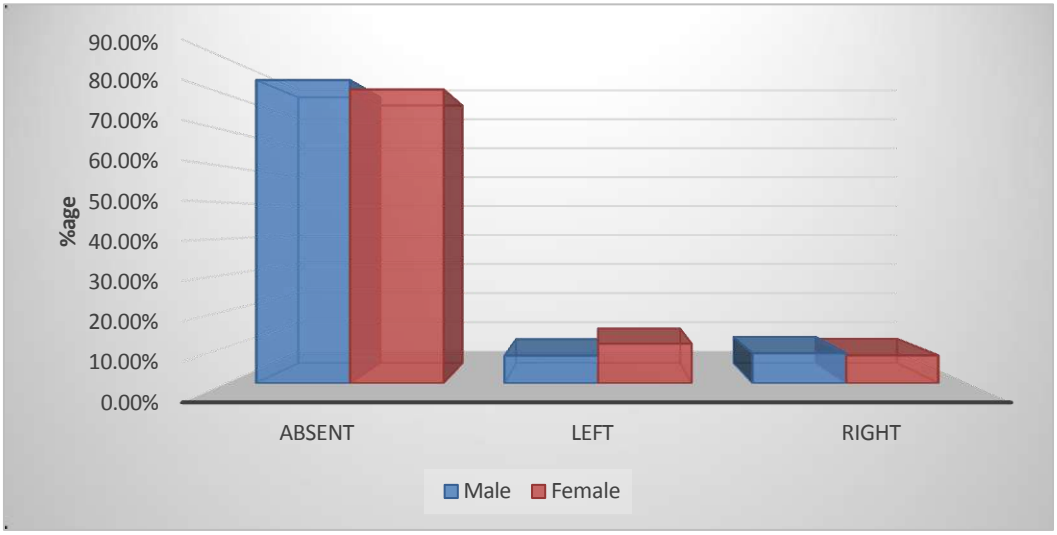


Table 27: Association of religion with an incidence corona mortis

Presence	religion					chi-square	p-value
	Hindu	Sikh	Muslim	Christian	Total		
	n %	n %	n %	n %	n %		
absent	113 81.90%	131 82.90%	2 100.00%	2 100.00%	248 82.70%	0.9	0.8
Present	25 18.10%	27 17.10%	0 0.00%	0 0.00%	52 17.30%		
Total	138 100.00%	158 100.00%	2 100.00%	2 100.00%	300 100.00%		

Table 27 examines the association between religion and the incidence of Corona Mortis. Among the 300 cases, 82.7% (248 cases) were absent of Corona Mortis. Of these, 81.9% (113 cases) were Hindu, 82.9% (131 cases) were Sikh, and 100% (2 cases each) were Muslim and Christian. For the 52 cases (17.3%) with Corona Mortis, 18.1% (25 cases) were Hindu, 17.1% (27 cases) were Sikh, and none were Muslim or Christian. The chi-square value of 0.9 and p-value of 0.8 indicate no significant association between religion and the incidence of Corona Mortis.

Figure 27: Association of religion with an incidence corona mortis

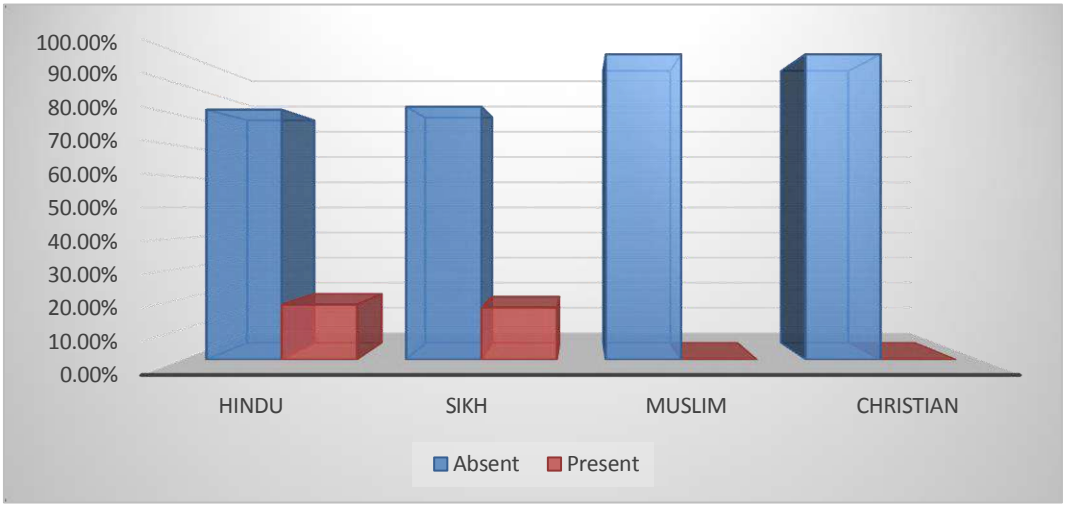


Table 28: Association of religion with laterality of corona mortis in radiological cases

Presence	religion					chi-square	p-value
	Hindu	Sikh	Muslim	Christian	Total		
	n %	n %	n %	n %	N %		
Absent	113 81.9%	131 82.9%	2 100.0%	2 100.0%	248 82.7%	1.65	0.95
Left	15 10.9%	13 8.2%	0 0.0%	0 0.0%	28 9.3%		
Right	10 7.2%	14 8.9%	0 0.0%	0 0.0%	24 8.0%		
Total	138 100.0%	158 100.0%	2 100.0%	2 100.0%	300 100.0%		

Table 28 presents the association between religion and the laterality of Corona Mortis in radiological cases. Among the 300 cases, 82.7% (248 cases) were absent of Corona Mortis. Of these, 81.9% (113 cases) were Hindu, 82.9% (131 cases) were Sikh, and 100% (2 cases each) were Muslim and Christian. For the 52 cases (17.3%) with Corona Mortis, 10.9% (15 cases) were left-sided (10.9% Hindu, 8.2% Sikh), and 8.0% (24 cases) were right sided (7.2% Hindu, 8.9% Sikh). The chi-square value of 1.65 and p-value of 0.95 indicate no significant association between religion and the laterality of Corona Mortis.

Figure 28: Association of religion with laterality of corona mortis in radiological cases

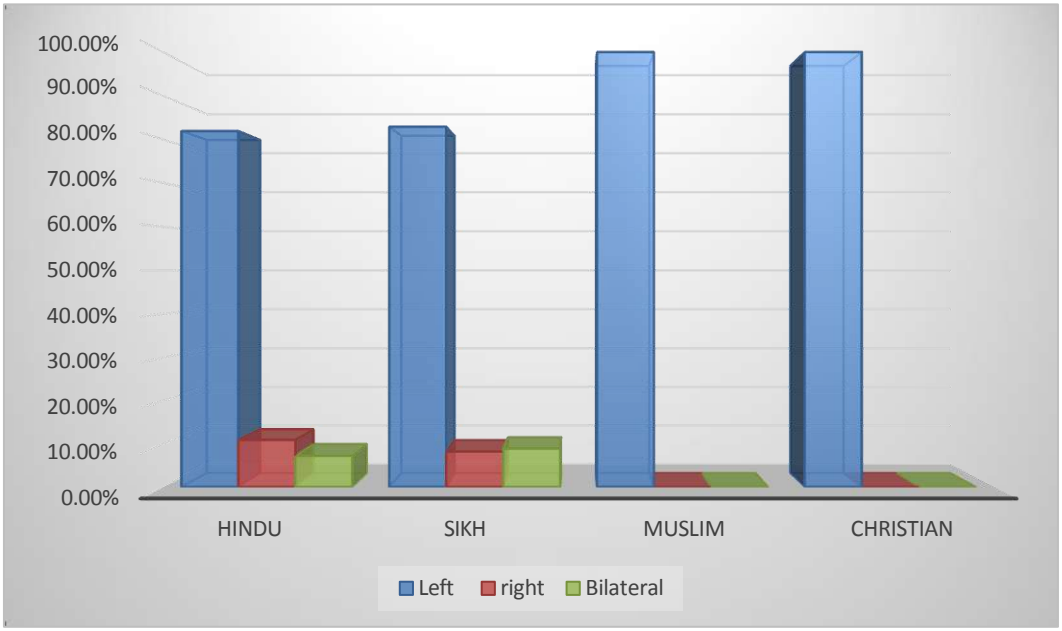


Table 29: Comparison of mean distance of corona mortis according to laterality in radiological cases

Laterality	N	Mean	Std. Deviation	t-test	p-value
Left	28	56.22	5.33	-.69	.43
Right	24	57.27	5.65		

Table 29 compares the mean distance of Corona Mortis according to laterality in radiological cases. For the left side, the mean distance was 56.22 mm with a standard deviation of 5.33 mm. For the right side, the mean distance was 57.27 mm with a standard deviation of 5.65 mm. The t-test value of -0.69 and p-value of 0.43 indicate no significant difference in the mean distances between the left and right sides.

Figure 29: Comparison of mean distance of corona mortis according to laterality in radiological cases

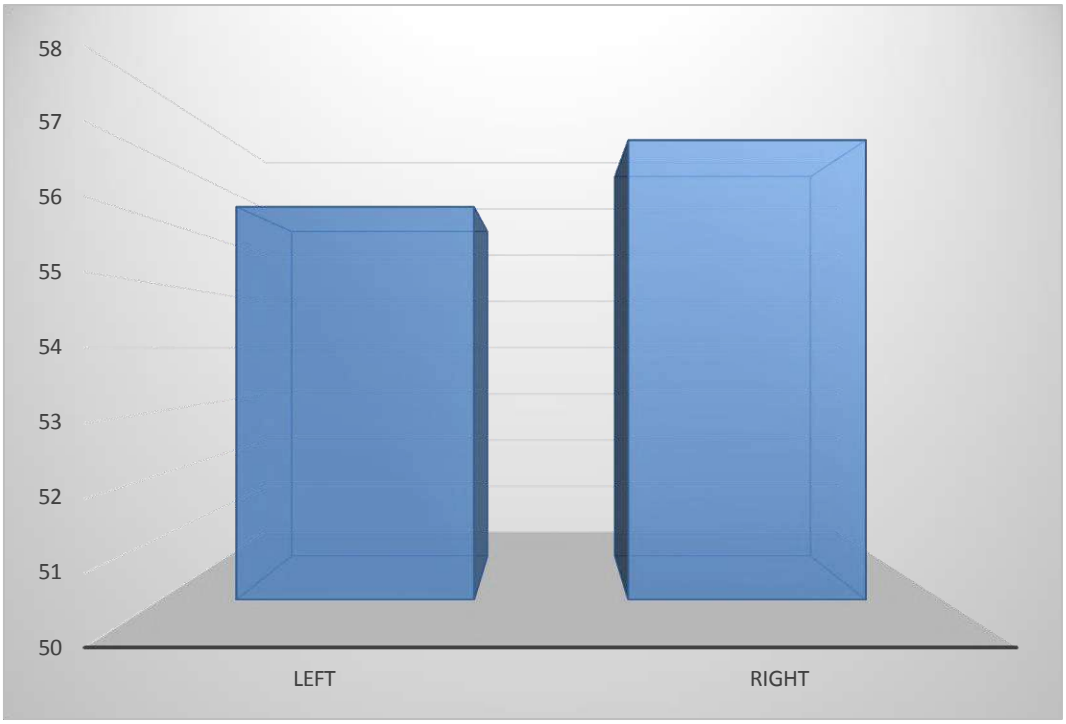


Table 30: Comparison of mean distance of corona mortis with respect to religion

Religion	N	Mean	Std. Deviation	t-test	p-value
Hindu	25	57.93	4.06	1.58	0.12
Sikh	27	55.57	6.34		

Table 30 compares the mean distance of Corona Mortis according to religion. For Hindus, the mean distance was 57.93 mm with a standard deviation of 4.06 mm. For Sikhs, the mean distance was 55.57 mm with a standard deviation of 6.34 mm. The t-test value of 1.58 and p-value of 0.12 indicate no significant difference in the mean distances between Hindus and Sikhs.

Figure 30: Comparison of mean distance of corona mortis with respect to religion

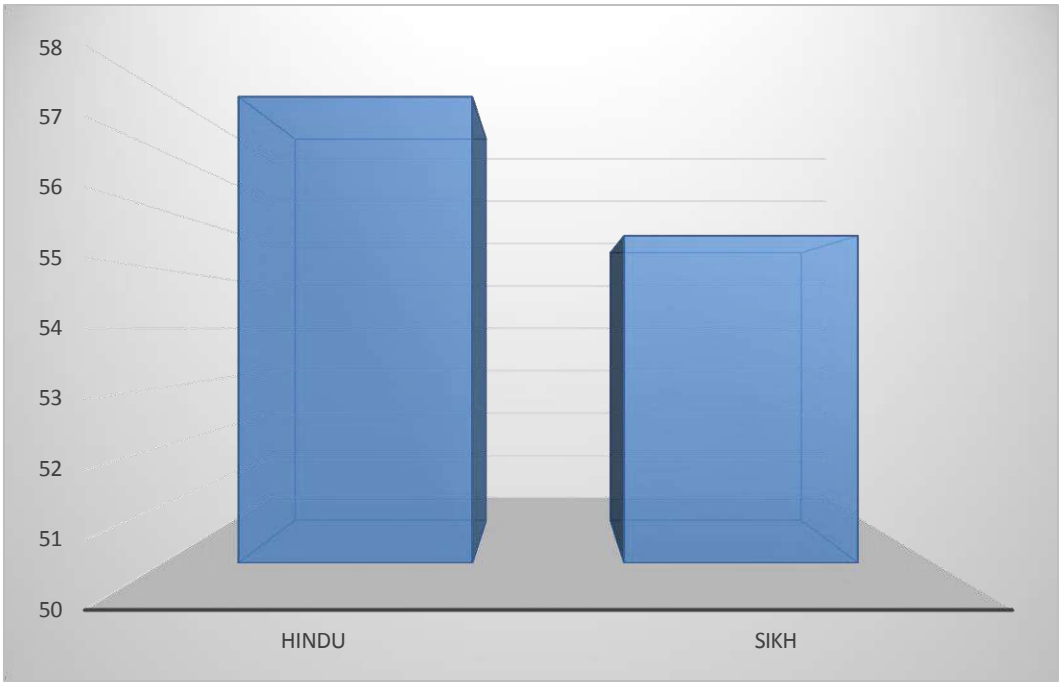
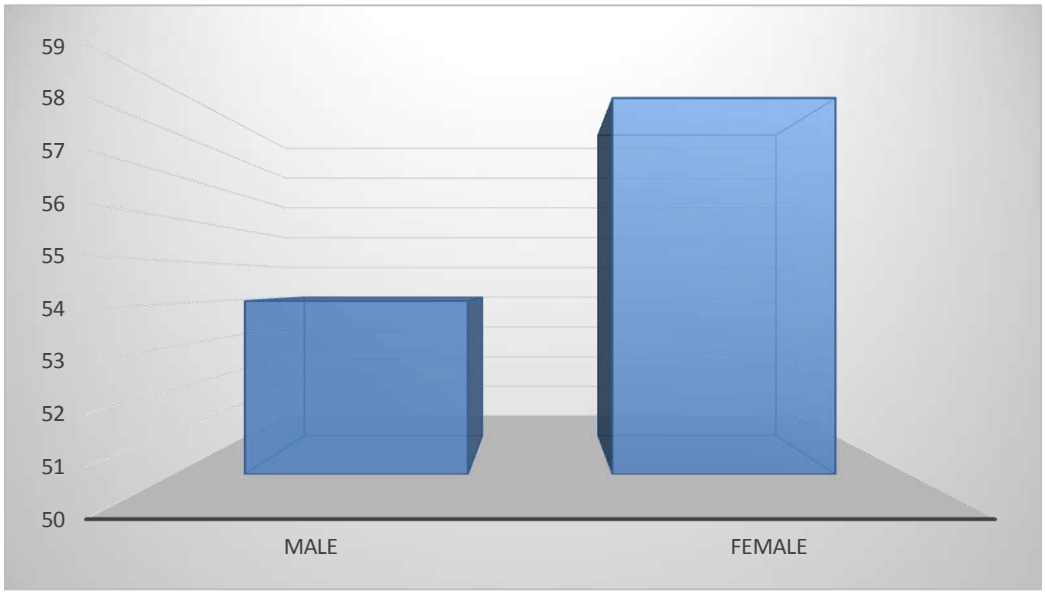


Table 31: Comparison of mean distance of corona mortis with respect to gender

Gender	N	Mean	Std. Deviation	Man whitney	p-value
Male	23	54.06	4.70	502	.002
Female	29	58.79	5.15		

Table 31 compares the mean distance of Corona Mortis with respect to gender. For males, the mean distance was 54.06 mm with a standard deviation of 4.70 mm. For females, the mean distance was 58.79 mm with a standard deviation of 5.15 mm. The Mann-Whitney test value of 502 and p-value of 0.002 indicate a significant difference in the mean distances between males and females, with females having a greater mean distance than males.

Figure 31: Comparison of mean distance of corona with respect to gender



Overall results (Cadaver+Cases +Radio)

Table 32: Overall distribution of cases with respect to gender

	Frequency	Percent
Male	185	51.5
Female	174	48.5
Total	359	100.0

Table 32 shows that out of 359 total cases, 51.5% (185 cases) were male and 48.5% (174 cases) were female.

Figure 32: Overall distribution of cases with respect to gender

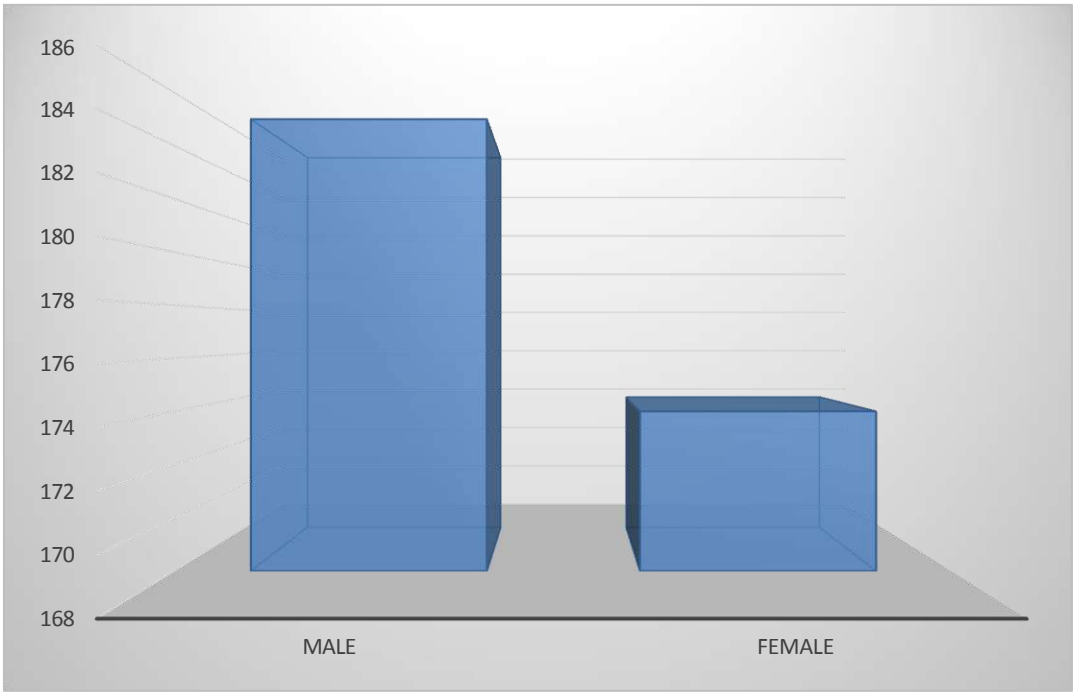


Table 33: Distribution of overall cases with respect to incidence of corona mortis

	Frequency	Percent
Absent	285	79.4
Present	74	20.6
Total	359	100.0

In terms of the incidence of Corona Mortis (Table 33), 79.4% (285 cases) did not present with Corona Mortis, while 20.6% (74 cases) did.

Figure 33: Distribution of overall cases with respect to incidence of corona mortis

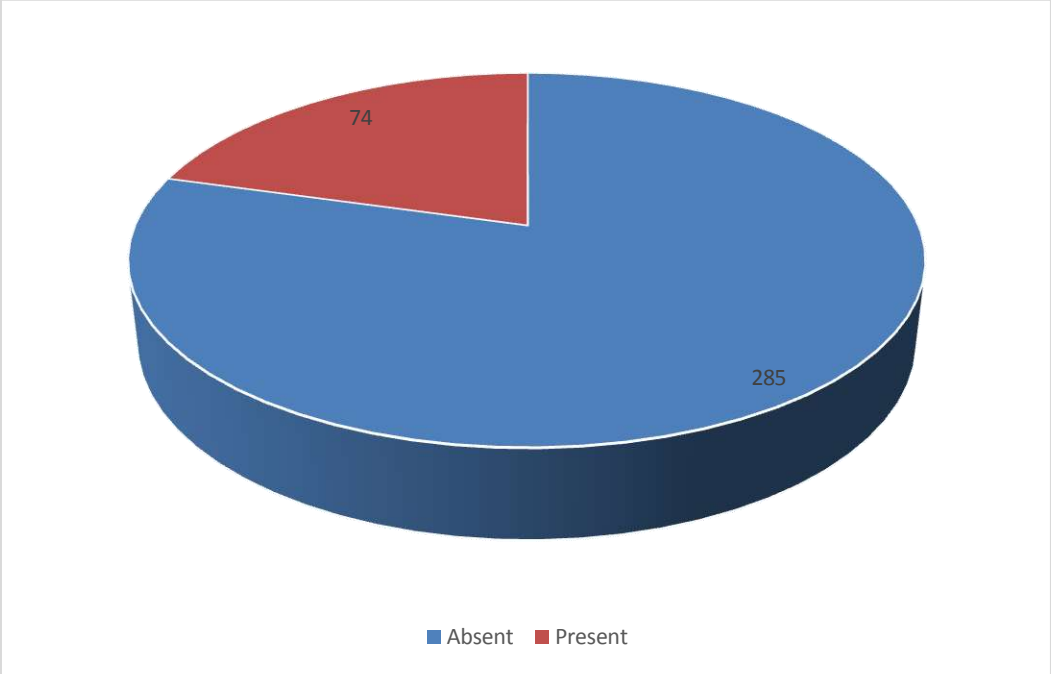


Table 34: Distribution of overall cases of corona mortis with respect to laterality

	Frequency	Percent
Absent	285	79.4
Left	39	10.9
Right	35	9.7
Total	359	100.0

When examining the laterality of Corona Mortis among the cases (Table 34), it was found that 79.4% (285 cases) had no Corona Mortis. Among the cases with Corona Mortis, 10.9% (39 cases) were left-sided and 9.7% (35 cases) were right-sided.

Figure 34: Distribution of overall cases of corona mortis with respect to laterality

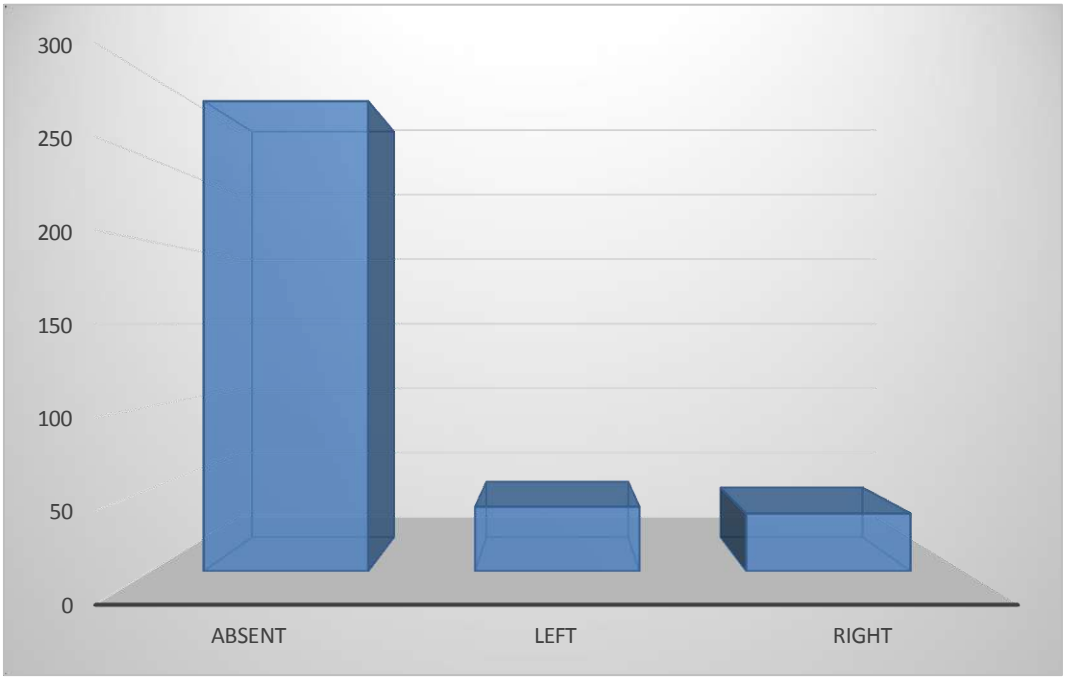


Table 35: Association of gender with the presence of corona mortis in overall cases

Presence	gender						chi-square	p-value
	Male		Female		Total			
	n	%	n	%	n	%		
Absent	143	77.3%	142	81.6%	285	79.4%	1.01	0.31
Present	42	22.7%	32	18.4%	74	20.6%		
Total	185	100.0%	174	100.0%	359	100.0%		

The association between gender and the presence of Corona Mortis (Table 35) revealed that 77.3% (143 out of 185) of males and 81.6% (142 out of 174) of females had no Corona Mortis. Conversely, 22.7% (42 out of 185) of males and 18.4% (32 out of 174) of females had Corona Mortis, with no significant gender difference (chi-square = 1.01, p = 0.31).

Figure 35: Association of gender with the presence of corona mortis in overall cases

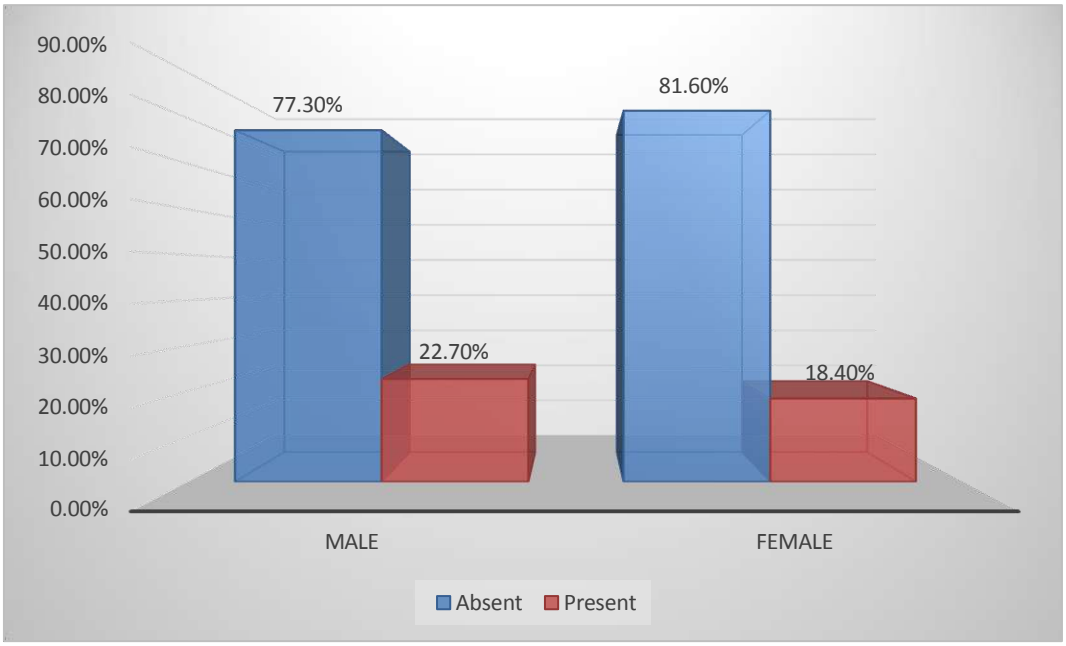


Table 36: Association of gender with the laterality of corona mortis in overall cases

	Gender						chi-square	p-value
	Male		Female		Total			
	n	%	n	%	n	%		
Absent	143	77.3%	142	81.6%	285	79.4%	2.00	0.366
Left	20	10.8%	19	10.9%	39	10.9%		
Right	22	11.9%	13	7.5%	35	9.7%		
Total	185	100.0%	174	100.0%	359	100.0%		

The laterality of Corona Mortis in relation to gender (Table 36) showed that 77.3% (143 males) and 81.6% (142 females) had no Corona Mortis. Among those with Corona Mortis, 10.8% (20 males) and 10.9% (19 females) were left-sided, while 11.9% (22 males) and 7.5% (13 females) were right-sided, indicating no significant gender association (chi-square = 2.00, p = 0.366).

Figure 36: Association of gender with the laterality of corona mortis in overall cases

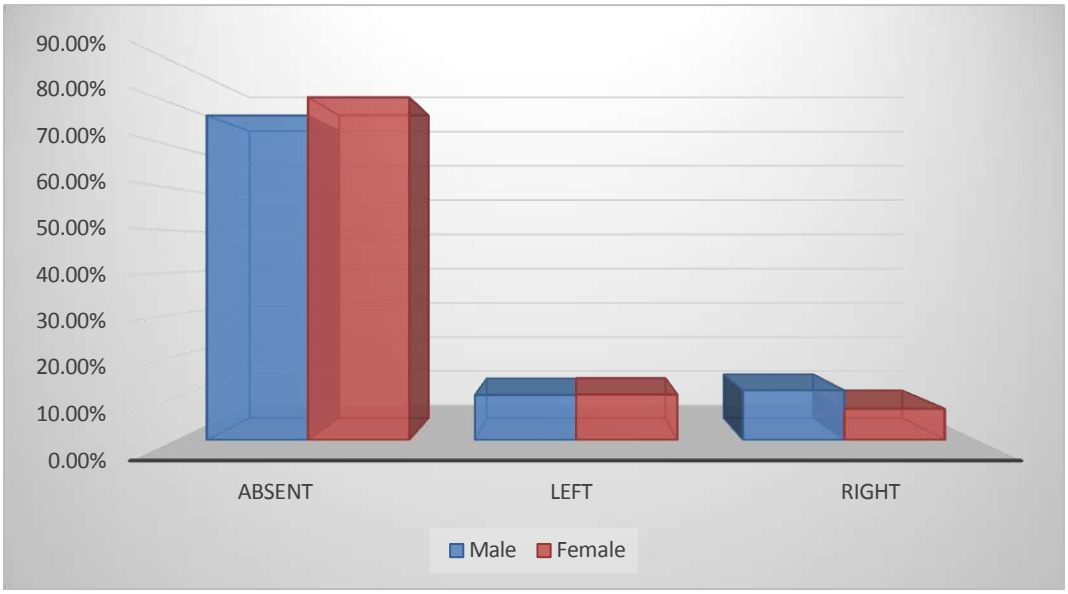


Table 37: Mean distance of corona mortis according to laterality in overall cases

presence	N	Mean	Std. Deviation	t-test	p-value
Left	39	56.88	5.47	-0.55	0.58
Right	35	57.57	5.21		

The mean distance of Corona Mortis according to laterality in overall cases (Table 37) was 56.88 mm (SD = 5.47) for the left side and 57.57 mm (SD = 5.21) for the right side, with no significant difference (t = -0.55, p = 0.58).

Figure 37: Mean distance of corona mortis according to laterality in overall cases

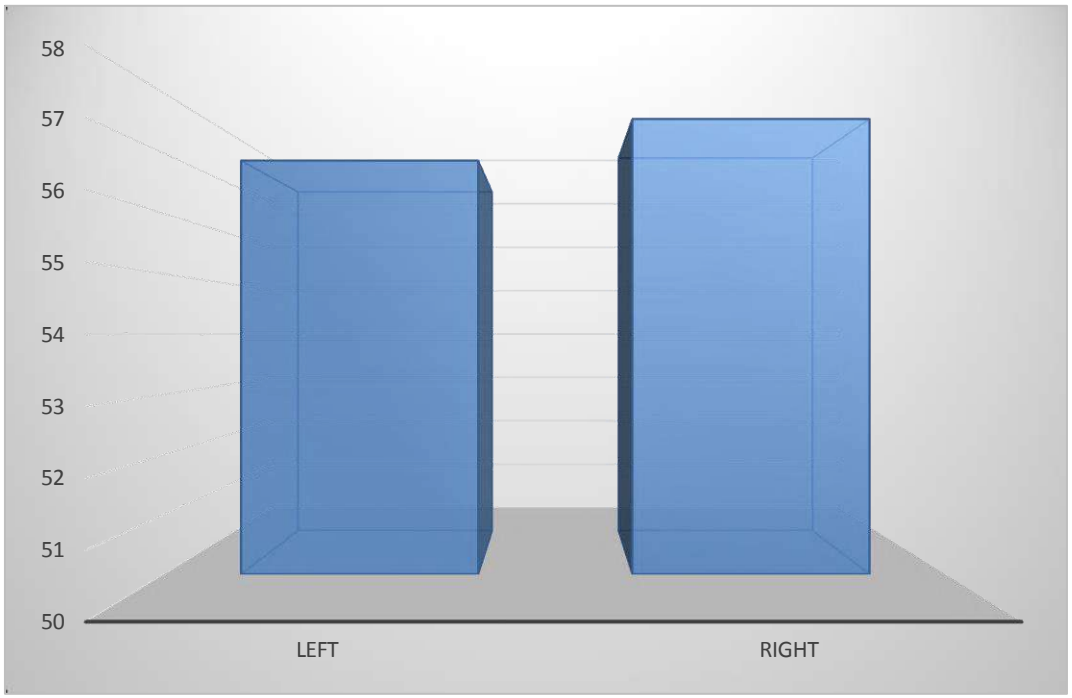
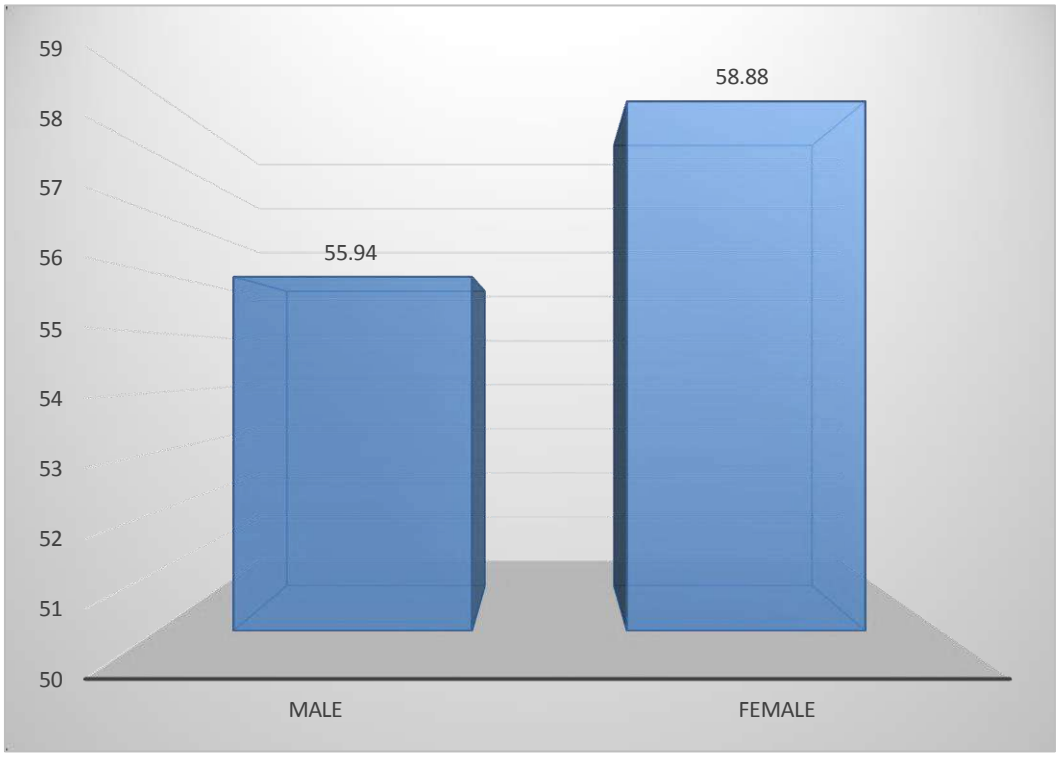


Table 38: Comparison of mean distance of corona mortis in overall cases with respect to gender

	N	Mean	Std. Deviation	t-test	p-value
Male	42	55.94	5.32	-2.42	0.01
Female	32	58.88	4.93		

The comparison of mean distances by gender (Table 38) showed that males had a significantly shorter mean distance of 55.94 mm (SD = 5.32) compared to females, who had a mean distance of 58.88 mm (SD = 4.93) (t = -2.42, p = 0.01).

Figure 38: Comparison of mean distance of corona mortis in overall cases with respect to gender



DISCUSSION

Historically, the Corona Mortis is considered an aberrant anastomosis between the Obturator and External Iliac vascular systems and can be either an arterial or venous connection or both. However, its exact definition remains controversial. Some authors define the CMOR as any anastomosis between the Internal and External Iliac systems that traverses behind the Superior Pubic Rami, given the similar risk of bleeding if damaged. Others argue that the CMOR specifically refers to the anastomosis of the Obturator vessel and the Inferior Epigastric vessel. Therefore, understanding the anatomy of these anastomoses is crucial to avoid iatrogenic vascular complications during surgical procedures in the retropubic space.

Broek et al.[45] documented four cases of elderly patients experiencing massive hemorrhages after pubic ramus fractures. Larsson et al.[46] and Gobrecht et al.[47] described patients who went into shock due to severe hemorrhages following operations in the retropubic space, necessitating surgical revision to control the bleeding.

This study was undertaken at the Department of Orthopedics at Dayanand Medical College and Hospital, Ludhiana, to investigate the Incidence and Variations of the Corona Mortis (CM) in Anatomical (cadaveric), Radiological (angiography), and Intraoperative patients within the Indian population.

CADAVERIC DATA

In our study, all the cadavers examined were male, indicating a lack of female cadaveric data, which may limit the findings to the male population only. In comparison, Alcestis Stavropoulou-Deli[48] conducted a study on 35 adult female cadavers, focusing exclusively on the female pelvis. Leite TFO[42] dissected 60 hemipelvis of adult corpses, comprising 50 men and 10 women, offering insights from both genders, though predominantly male. Bargoria et al[49] found Corona Mortis in 8 (53%) female specimens and 7 (47%) male hemipelvis, highlighting significant findings in both genders. Kashyap et al.[20] studied twelve cadavers, totaling 24 hemipelvis, with 11 males and 1 female, which is similar to our study in its male-dominated sample. Bharathi et al[31] conducted a study in South India, a total of 55 specimens were included for the study. Among the hemipelvis which were dissected 42 were males and 13 were females.

Study	**Total Cadavers**	**Male Cadavers**	**Female Cadavers**	**Notes**
Our Study	8(16 hemipelvis)	All males	None	Indicates a lack of female data
Bharathi et al.[31]	55	42	13	Higher male gender representation
Alcestis Stavropoulou-Deli[48]	35	None	35	Focused exclusively on the female pelvis
Leite TFO[42]	60 hemipelvis	50	10	Predominantly male
Kashyap et al.[20]	12 cadavers (24 hemipelvis)	11	1	A similar male-dominated sample to our study

Incidence

In our study, the Corona Mortis (CMOR) was present in 62.5% of the cadavers, indicating that this anatomical variation is relatively common. Its absence in 37.5% of cases demonstrates variability in its occurrence.

Similarly, Kashyap et al.[20] also observed CMOR in 58.3% of hemipelvis, aligning closely with our findings. Another study by Okcu G et al.[8] found vascular communication in 61% of cadaver hemipelvis, which is comparable to our study.

In contrast, a study by Khirul-Ashar NA[29] found CMOR in 89% of 73 cadavers, with an absence in only 11%, showing a much higher prevalence than in our study.

The study by Bargoria et al[49] found CMOR in 37.5% of cases, while 62.5% did not have either venous or arterial anastomosis between the obturator and the external iliac systems, which is significantly lower than the prevalence observed in our study.

Bharathi et al[31] conducted a study in South India and found that CMOR was observed in 35 out of 55 specimens (63.64%) of the cadaveric hemipelvis.

Study	**CM Presence**	**CM Absence**	**Notes**
Our Study	62.5%	37.5%	-
Kashyap et al.[20]	58.3%	41.7%	Similar to our findings
Okcu G et al.[8]	61%	39%	Similar to our findings
Khirul-Ashar NA[29]	89%	11%	Much higher prevalence than our study
Bharathi et al.[31]	63.64%	36.36%	Similar prevalence to our study
V.K. Bargoria[49]	37.5%	62.5%	Much lower prevalence than our study

This table summarizes the prevalence of the Corona Mortis in various studies, highlighting the differences and similarities with our findings.

Laterality

In our study, among the cadavers with Corona Mortis (CMOR), it was evenly distributed between the left (50%) and right (50%) sides, indicating no lateral dominance in its presence.

A study by Bargoria et al[49] showed that of the 15 hemipelvis with CMOR, 8 (53%) were on the left side while 7 (47%) were on the right side, which is almost similar to our study.

Kashyap et al.[20] concluded that CMOR was observed in 5 hemipelvis (35.8%) on the right side, 9 hemipelvis (64.2%) on the left side out of a total of 14 hemipelvis cases, showing a higher prevalence on the left side as compared to the right side.

Study	**Left Side (%)**	**Right Side (%)**	**Notes**
Our Study	50%	50%	No lateral dominance
Bargoria et al[49]	53%	47%	Similar to our study
Kashyap et al.[20]	64.2%	35.8%	Higher on the left side

This table summarizes the lateral distribution of the Corona Mortis in various studies, highlighting the differences and similarities with our findings.

Mean distance of corona mortis

In our study, the mean distance of the Corona Mortis from pubic symphysis on the left side was 57 mm with a standard deviation of 7.874 mm. The mean distance on the right side was 58.2 mm with a standard deviation of 6.38 mm. The p-value was 0.671, indicating no significant difference between the mean distances on the left and right sides.

Similarly, in a study conducted by Sengodan VC,[32] the mean distance of the CMOR from the pubic symphysis on the right side was 60 mm, whereas it was 51.30 mm on the left side, showing a larger difference between the sides compared to our study.

Kashyap et al[20] noted an average distance of the anastomosis from pubic symphysis as 56 mm(range:35-70mm) while Khirul Ashar et al[29] calculated the mean distance of CMOR from pubic symphysis to be 54.72 mm with a standard deviation of 9.35 mm

In a study by Bharathi et al[31] The mean distance of Corona Mortis vessel from the pubic symphysis was 52.6 mm in males and 56.3 mm in females, thus the distance of the anastomotic vessel remains consistent in both the sexes. Our study included only male hemipelvis hence distances among gender could not be evaluated.

Study	**Mean Distance (Left Side)**	**Std. Dev. (Left Side)**	**Mean Distance (Right Side)**	**Std. Dev. (Right Side)**	**p-value**	**Notes**
Our Study	57 mm	7.874 mm	58.2 mm	6.38 mm	0.671	No significant difference
Sengodan VC[32]	51.30 mm	N/A	60 mm	N/A	N/A	Larger difference between sides

This table compares the mean distances of the CMOR from the pubic symphysis in our study and Sengodan VC's study, highlighting the differences in measurements and statistical significance.

Surgical data

Our study was conducted among 29 patients who underwent surgery, with 12 (41.4%) of them being female and 17 (58.6%) being male.

Similarly, Azer Abbas[34] conducted a study among 30 patients, with 12 being female and 18 male.

Study	**Total Patients**	**Female Patients (%)**	**Male Patients (%)**
Our Study	28	12 (42.9%)	16 (57.1%)
Azer Abbas[34]	30	12 (40%)	18 (60%)

This table summarizes the gender distribution of the patients in our study and the study conducted by Azer Abbas.

In our surgical study, Corona Mortis (CMOR) was present in 31% of the cases, which is significantly lower compared to the cadaveric data where it was found in 62.5% of cases. It was observed that while CMOR was frequently identified in cadaveric studies, its occurrence was much less frequent during surgical procedures. This discrepancy could be attributed to the possibility that in some cases of pelvic trauma injury to venous plexus of retropubic space can lead to thrombosis of vessels which makes identification intra-operatively more difficult. Also, differences in surgical techniques of various surgeons might play a role in identification of CMOR during approach to pelvis. In our study this variation in surgical technique is symbolized by different incidence of CMOR observed in cases performed by the 2 surgeons primarily involved in the anterior approach to pelvis with incidence being 41.66% and 22.58% respectively.

In Azer Abbas's study,[34] CMOR was found in 43% of the patients, which is higher than our surgical findings.

In our surgical study, the incidence of CMOR was lower compared to cadaveric studies, which typically report higher percentages of CMOR presence. The scarcity of comparative studies between surgical and cadaveric data highlights a lacunae in the literature. While cadaveric studies often provide detailed anatomical insights, surgical findings may reflect real-time clinical scenarios where anatomical variations can present differently due to various factors like patient positioning, surgical approach, and anatomical variations.

In the surgical cases studied, there was no significant association found between gender and religion to the incidence or to the laterality of CMOR. Additionally, the mean distances of CMOR from the pubic symphysis on the left side (59.91 mm) and right side (58.26 mm) did not show a significant difference between genders.

This suggests that in the context of surgical findings, gender, laterality, and religious factors did not play a significant role in determining the presence or anatomical characteristics of Corona Mortis.

Radiological data

The reported incidence of Corona Mortis varies across different radiological studies. In our own radiological study, CMOR was identified in 17.3% of cases, with the absence noted in 82.7% of cases examined radiologically. Bhoil et al[38] calculated incidence of 14 % among 100 patients who underwent CT angiography with presence seen in 28 out of 200 hemipelvis examined for CMOR. Karakut et al.[50] observed incidence of 28.5% among patients undergoing angiography, focusing on vascular imaging to detect CMOR. Smith et al[44] reported an incidence of CMOR at 29%, based on advanced CT imaging techniques. Studies focusing on CT angiography have shown CMOR incidences ranging from 25% to 33%, indicating variability influenced by imaging modality and study population characteristics. Steinberg et al.,[26] in their CT angiographic study, found that Corona Mortis was present in 33%(66 out of 200) of the cases examined with unilateral incidence in 36 cases and bilateral incidence in 15 cases. Their study did not observe any significant association between gender, laterality, religion, and the presence of CMOR in radiological cases.

Study	**Incidence of CMOR (%)**	**Notes**
Our Radiological Study	17.3%	Absent in 82.7% of cases
Bhoil R et al[38]	14%	Similar to our study done in Indian population
Karakut et al.[50]	28.5%	Among patients undergoing angiography
Smith et al.[44]	29%	Routine multi-detector CT studies
EL Steinberg et al.[26]	33%	Evaluated by means of 3 dimensional CTA
Studies on CT Angiography	25-33%	Wide range in incidence reported

This table provides an overview of the incidence of Corona Mortis as reported in different radiological studies, highlighting the variations observed across different populations and imaging techniques.

Study	Male Participants	Female Participants
Our Radiological Study	72 (48%)	78 (52%)
Bhoil R et al.[38]	67	33

In our radiological study, we examined a total of 300 hemipelvis, with 144 (48%) being male and 156 (52%) female. This gender distribution reflects a relatively balanced representation of both sexes in our study cohort.

In contrast, R. Bhoil et al.[38] conducted a study involving 200 hemipelvis, with 134 belonging to male participants and 66 to female participants. This distribution emphasizes a higher representation of male subjects compared to females in their study population.

Association of Gender with Incidence of CMOR: There was no statistically significant association found between gender and the incidence of CMOR in radiological cases. This suggests that CMOR occurrence does not show a significant difference based on gender in the study population.

In our radiological study, the majority of patients identified as Sikh (52.7%) and Hindu (46%), with Muslims and Christians each comprising only 0.7% of the study population. However, there was no specific study found that compared patients based on religion. Based on our study no significant difference was seen in incidence of CMOR among different religious groups. This demographic information provides insight into the religious diversity within the study cohort, highlighting the predominant Sikh and Hindu representation.

In terms of the laterality of Corona Mortis, in our study, it was found on the left side in 11.3% of patients, on the right side in 8.7% patients. This distribution shows a varied occurrence across sides. Unilateral incidence was present in 20% of patients and bilateral incidence seen in 7.3% of patients.

Smith JC et al.[44] concluded that in their study, the prevalence of CMOR was fairly evenly distributed between the right and left sides, with 30% on the right and 28% on the left. Interestingly, 11 out of 50 patients had bilateral CMOR.

In a study by Simone Perandini et al.,[39] based on CT angiography a total of 90 arterial CMOR was identified out of 300 evaluated arteries, with 40 on the right side and 50 on the left side. Unilateral anastomosis was found in 21.33% of patients, while bilateral anastomosis was observed in 19.33%. No anastomosis was detected in 59.33% of patients.

Study	**Laterality Distribution of CMOR (%)**	**Bilateral CMOR (%)**	**Notes**
Our Study	Left: 11.3%, Right: 8.7%	7.3%	Distribution of CMOR in our radiological study
Smith JC et al.[44]	Right: 30%, Left: 28%	22%	Even distribution and bilateral cases observed
Simone Perandini et al.[39]	Right: 13.33%, Left: 16.67%	19.33%	Distribution and prevalence in arterial CMOR

This table provides an overview of the incidence of Corona Mortis as reported in different radiological studies comparing incidence of CMOR on either side of pelvis.

Comparison of Mean Distances: In our study, the mean distance of CMOR from the pubic symphysis was 56.22 mm ± 5.33 mm on the left side and 57.27 mm ± 5.65 mm on the right side. Similar findings regarding distance of CMOR were seen in other studies as shown.

Gender Differences in Distance: Females in our study had a mean distance of CMOR from pubic symphysis that was more than males on both the right and left side. In comparison, studies by Bhoil et al,[38] Steinberg et al[26] and Karakurt et al.[50] also reported significantly greater distances of CMOR for female compared to male hemipelvis, suggesting that the anatomical course of the artery may be influenced by pelvic morphology differences between genders.

Study	**Mean Distance of CMOR (mm)**	**Gender Differences**	**Notes**
Our Study	Left: 56.22 ± 5.33 mm, Right: 57.27 ± 5.65 mm	Females had greater mean distance than males	Study findings on CMOR distance in our research
Bhoil R et al.[38]	Left: 54.26 ± 5.2 mm, Right : 54.55 ± 4.9 mm	Females had greater distance than compared to males	Attributed to lesser slope of pelvis, widely separated iliac spines
Steinberg, EL et al.[26]	Left: 57.2 mm, Right: 55.2 mm	Greater distance in females only on left side	Influence of pelvic morphology on CMOR course
Karakurt et al.[50]	Average for men 31.8 mm, for women 36.2 mm	Significant gender-based differences in distance	Anatomical considerations in CMOR location

Limitations

There are some limitations of our study, cadaveric data is only available from cadavers present in the anatomy department at the time of study which were exclusively male hence assessment of difference in distance of CMOR between male and female pelvises could not be done. CT angiography cases taken in study were not assessed for venous CMOR which may have higher incidence than arterial counterpart thus have significant clinical influence. Surgical cases observed in the study were assessed based on presence or absence of CMOR with venous or arterial subtype not assessed due to difficulty in dissection in trauma patients as well as failure to identify origin of the vessel since orthopedic procedures require extensive exposure of superior pubic rami for placement of implant. Thus the vessel is cauterized using energy source during the exposure itself for ease of surgery and to prevent iatrogenic complications. Additionally, cases by different surgeons were included in the study which further results in separate surgical techniques leading to difficulty in visualization of CMOR. Finally, the sample size of the study was less which necessitates need for further data for better understanding the clinical significance of this anastomosis.

SUMMARY AND CONCLUSION

This observational study was done over a period of 18 months (1st Feb 2022 - 31st Aug 2023) to study the Incidence and Variations of Corona Mortis (CMOR) based on surgical cases, cadaveric dissection and CT angiographies with the following results-

A. Surgical Cases: A total of 29 cases were operated. The surgical procedures involved exposure of unilateral superior pubic rami in 15 patients (15 hemi-pelvis) and exposure of bilateral superior pubic rami in 14 patients (28 hemi-pelvis). Therefore, a total of 43 hemipelvis were observed.

1. Out of the 43 hemi-pelvis observed (in 29 cases), Incidence rate was 27.9% (12 out of 43) with nearly equal distribution on either right (6 out of 12) or left (6 out of 12) side

2. Mean distance of CMOR from pubic symphysis was 59.91 mm on left side and 58.26 mm on right side.

3. No variations of CMOR were seen based on religion(p=0.45)(p=1) and gender(p=0.16)(p=0.48) in incidence and distance of CMOR from pubic symphysis.

B. Radiological data: A total of 150 Contrast enhanced CT scans of patients were examined with a total of 300 hemi-pelvis observed

1. Out of total 300 hemi-pelvis observed, Incidence rate was 17.3% (52 out of 300) with similar distribution on either right (24 out of 52) or left (28 out of 52) side.

2. Mean distance of CMOR from pubic symphysis was 56.22 mm on left side and 57.27 mm on right side.

3. No variations of CMOR based on religion were seen(p=0.8)(p=0.12). However, a variation in distance of CMOR was seen among female and male gender (p=0.002). Mean distance in females was 58.79 mm and in males was 54.06 mm.

C. Cadaveric Data: A total of 8 cadavers (16 hemi-pelvis) were dissected

1. Out of the 16 hemi-pelvis observed, Incidence rate was 62.5% (10 out of 16 cadaveric hemi-pelvis)

2. Mean distance of CMOR from pubic symphysis was 57 mm on left side and 58.20 mm on right side.

3. All cadavers examined were males, providing no female data, which limits the applicability of findings to the male population.

CONCLUSION: Corona Mortis (CMOR) or ‘Crown of Death” is a significant anatomical variant which has been found to have a variable incidence in literature. In our study which involved a total of 359 hemi-pelvis, Incidence rate of CMOR in hemi-pelvis ranged from 17.3% to 62.5% based on evidence from surgical(27.9%), radiological(17.3%) and anatomical/cadaveric(62.5%) subjects. No variations were seen in the incidence or distance of CMOR from pubic symphysis between religion or among the genders except in radiological study group in which female gender had a higher mean distance of the anastomosis from pubic symphysis. This finding can be attributed to female pelvis having more width along with a lesser slope of pubic rami as compared to male pelvis which results in a wider course of the vessel.

CMOR may get involved in patients suffering trauma or those undergoing pelvic surgery leading to severe hemorrhage and hypovolemic shock and knowledge about its incidence and variations is thus important for clinical management. With this incidence rate, meticulous dissections during pelvic surgeries is also essential to avoid intraoperative complications. Gender specific anatomical differences is also important to consider, as females have greater mean distance of CMOR from the pubic symphysis compared to males, necessitating tailored surgical approaches. Increasing awareness and training among surgeons, developing clinical guidelines and fostering interdisciplinary collaboration are vital for improving CMOR management.

Continuous research and updating clinical practices based on new findings will further enhance surgical outcomes. Additionally informing patients about the potential risks and ensuring informed consent can improve overall care.

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KEY TO MASTER CHART

BL BILATERAL

F FEMALE

IL ILIOINGUINAL APPROACH

M MALE

MS MODIFIED STOPPA'S APPROACH

S NO	SPECIMEN NO (HEMI-PELVIS)	AGE	GENDER	PRESENCE	TYPE	SIDE	DISTANCE
1	7	62	M	absent	N/A	left	N/A
2	7	62	M	present	arterial	right	61
3	3	82	M	present	arterial	left	50
4	3	82	M	present	arterial	right	55
5	24	88	M	present	arterial	left	58
6	24	88	M	present	arterial	right	52
7	135	84	M	absent	N/A	left	N/A
8	135	84	M	absent	N/A	right	N/A
9	131	81	M	absent	N/A	right	N/A
10	131	81	M	absent	N/A	left	N/A
11	100	57	M	present	venous	left	70
12	100	57	M	present	venous	right	68
13	112	80	M	present	venous	left	55
14	112	80	M	present	venous	right	55
15	184	65	M	present	venous	left	52
16	184	65	M	absent	N/A	right	N/A

S NO	MRD	NAME	DATE OF ADM	AGE	GENDER	RELIGION	APPROACH(MS/IL)	PRESENCE	TYPE	SIDE	DISTANCE(MM)	side observed
1	1599296	DS	8/30/2023	48	M	sikh	MS	present	arterial	left	60	LEFT
2	1422688	SK	11/29/2022	33	F	hindu	MS	absent	N/A	-	-	BL
3	1413586	PK	11/14/2022	41	F	sikh	MS	absent	N/A	-	-	BL
4	1308825	MK	5/22/2022	28	F	sikh	IL	absent	N/A	-	-	RIGHT
5	1594954	AKM	8/23/2023	39	M	hindu	MS	present	arterial	right	56	RIGHT
6	1294853	KR	4/28/2022	44	M	sikh	MS	absent	N/A	-	-	BL
7	1413717	BS	11/16/2022	68	M	sikh	MS	absent	N/A	-	-	RIGHT
8	1396544	SK	10/13/2022	71	F	hindu	MS	absent	N/A	-	-	LEFT
9	1430580	HD	12/13/2022	23	M	sikh	MS	present	arterial	left	55	LEFT
10	1317363	JN	6/21/2022	54	M	hindu	MS	absent	N/A	-	-	BL
11	1386941	AB	9/26/2022	43	F	hindu	MS	present	arterial	bilateral	R-58 ; L-59	BL
12	1278007	NS	3/29/2022	21	F	hindu	MS	absent	N/A	-	-	BL
13	1520566	GS	5/20/2023	22	M	sikh	MS	absent	N/A	-	-	BL
14	1507741	SK	4/28/2023	32	F	sikh	MS	absent	N/A	-	-	BL
15	1498304	JG	4/12/2023	37	M	hindu	MS	absent	N/A	-	-	BL
16	1491742	U	4/2/2023	26	F	hindu	IL	absent	N/A	-	-	RIGHT
17	1509524	MS	5/4/2023	56	M	sikh	MS	absent	N/A	-	-	RIGHT
18	1508334	JS	4/29/2023	26	M	sikh	MS	present	arterial	right	57.8	BL
19	1511965	C	5/6/2023	22	M	sikh	MS	absent	N/A	-	-	BL
20	1569548	NS	8/11/2023	22	M	hindu	MS	absent	N/A	-	-	BL
21	1500728	Gs	4/17/2023	40	M	sikh	IL	absent	N/A	-	-	RIGHT
22	1453138	DR	1/28/2023	41	M	hindu	IL	absent	N/A	-	-	RIGHT
23	1479220	R	3/12/2023	20	F	hindu	IL	present	arterial	left	62	LEFT
24	1091833	HA	7/17/2022	32	F	hindu	MS	absent	N/A	-	-	RIGHT
25	1553411	DS	7/15/2023	43	M	sikh	MS	present	arterial	bilateral	R-62 ; L-65	BL
26	1304190	KJ	5/15/2022	57	F	hindu	MS	absent	-	-	-	BL
27	1395285	GS	10/10/2022	40	M	sikh	IL	present	arterial	left	58.5	LEFT
28	1433875	PK	12/19/2022	60	F	sikh	IL	absent	-	-	-	LEFT
29	1270433	RS	3/24/2022	43	M	sikh	MS	present	arterial	right	R-58	RIGHT

S NO	MRD	NAME	DATE OF CT	AGE	GENDER	RELIGION	ARTERY	IF YES, SIDE	DISTANCE (MM)
1	1395946	HK	15-10-22	16	M	hindu	N/A	absent	N/A
2	1328923	AK	15-10-22	63	M	hindu	N/A	absent	N/A
3	1397421	FS	16-10-22	70	M	sikh	N/A	absent	N/A
4	1359762	SKJ	17-10-22	52	M	hindu	arterial	right	54.8
5	1190291	GK	21-10-22	67	F	sikh	N/A	absent	N/A
6	526200	AD	25-10-22	46	F	hindu	arterial	bilateral	R-65.9 ; L-61.6
7	222965	AK	25-10-22	64	M	hindu	arterial	right	53.6
8	1397539	SK	25-10-22	55	F	hindu	arterial	right	60.55
9	871764	AM	25-10-22	34	F	hindu	N/A	absent	N/A
10	1361941	RR	26-10-22	41	M	hindu	N/A	absent	N/A
11	1384637	SK	27-10-22	41	M	hindu	N/A	absent	N/A
12	1361574	HS	27-10-22	40	M	sikh	N/A	absent	N/A
13	1403333	AK	28-10-22	25	F	sikh	N/A	absent	N/A
14	1405175	A	29-10-22	35	F	hindu	N/A	absent	N/A
15	1405793	IK	31-10-22	20	F	sikh	N/A	absent	N/A
16	1408466	HK	04-11-22	64	F	sikh	arterial	bilateral	R-59.5 ; L-67
17	711535	JK	06-11-22	69	F	sikh	N/A	absent	N/A
18	1410721	NJ	09-11-22	67	F	hindu	N/A	absent	N/A
19	1319922	CB	09-11-22	67	F	sikh	N/A	absent	N/A
20	1411590	HK	10-11-22	60	F	sikh	arterial	left	60.4
21	1244869	MR	14-11-22	40	M	hindu	N/A	absent	N/A
22	1164819	BD	14-11-22	56	F	hindu	arterial	left	54.8
23	1412484	GS	14-11-22	73	M	hindu	N/A	absent	N/A
24	1413799	ND	14-11-22	57	F	hindu	arterial	right	61.4
25	1413616	JK	15-11-22	35	F	hindu	N/A	absent	N/A
26	1414526	GC	15-11-22	61	M	hindu	N/A	absent	N/A
27	762977	GK	15-11-22	40	F	sikh	N/A	absent	N/A
28	1413699	SK	16-11-22	48	F	sikh	N/A	absent	N/A
29	1242261	HK	17-11-22	63	M	hindu	N/A	absent	N/A
30	1413079	RG	17-11-22	46	M	hindu	N/A	absent	N/A
31	1412488	RK	17-11-22	63	F	sikh	N/A	absent	N/A
32	1405937	RK	17-11-22	30	M	hindu	N/A	absent	N/A
33	512	DSG	17-11-22	52	F	hindu	N/A	absent	N/A

S NO	MRD	NAME	DATE OF CT	AGE	GENDER	RELIGION	ARTERY	IF YES, SIDE	DISTANCE (MM)
34	1409091	SD	17-11-22	60	F	hindu	arterial	left	61.1
35	1415256	RB	18-11-22	46	F	hindu	N/A	absent	N/A
36	1415785	AK	18-11-22	75	F	sikh	N/A	absent	N/A
37	1389342	SK	18-11-22	39	F	sikh	arterial	left	56.4
38	1090076	SS	19-11-22	76	F	hindu	arterial	left	51.8
39	1410637	KD	21-11-22	64	F	hindu	N/A	absent	N/A
40	1404891	PS	21-11-22	74	M	sikh	N/A	absent	N/A
41	1229853	BS	21-11-22	56	M	sikh	N/A	absent	N/A
42	1358421	MD	22-11-22	46	F	hindu	N/A	absent	N/A
43	1416532	SK	22-11-22	45	F	sikh	N/A	absent	N/A
44	1414072	BK	22-11-22	64	F	sikh	N/A	absent	N/A
45	1418729	GS	22-11-22	87	M	sikh	N/A	absent	N/A
46	1419063	PK	22-11-22	58	F	sikh	arterial	bilateral	R-52.3 ; L-53.4
47	1417654	HS	24-11-22	45	M	sikh	arterial	left	53.5
48	1309172	RP	25-11-22	82	M	hindu	arterial	bilateral	R-53.8 ; L-52.6
49	1420401	JS	25-11-22	26	M	sikh	N/A	absent	N/A
50	1298416	S	26-11-22	34	F	hindu	arterial	left	58.3
51	1421322	SK	26-11-22	28	M	hindu	N/A	absent	N/A
52	1420361	UR	26-11-22	71	F	hindu	arterial	left	61.6
53	1421251	MS	26-11-22	55	M	sikh	arterial	left	41.5
54	1417660	AS	27-11-22	78	M	sikh	arterial	right	55
55	1421358	MS	28-11-22	34	M	sikh	arterial	bilateral	R-50.4 ; L-52.7
56	1422593	RB	28-11-22	44	F	hindu	N/A	absent	N/A
57	1421887	SR	28-11-22	53	F	hindu	N/A	N/A	N/A
58	1421842	SC	28-11-22	37	M	hindu	N/A	absent	N/A
59	1259737	MK	28-11-22	56	F	sikh	N/A	absent	N/A
60	1420673	RK	28-11-22	37	M	hindu	N/A	absent	N/A
61	1422234	NK	28-11-22	38	F	sikh	N/A	absent	N/A
62	913679	GK	01-12-22	58	F	sikh	arterial	bilateral	R-59.6 ; L-61.2
63	1345968	SS	01-12-22	55	M	sikh	N/A	absent	N/A
64	1422651	KS	01-12-22	50	M	sikh	N/A	absent	N/A
65	927625	KR	01-12-22	49	F	hindu	N/A	absent	N/A
66	1426062	AK	04-12-22	22	M	hindu	arterial	bilateral	R-62.3 ; L-63.5

S NO	MRD	NAME	DATE OF CT	AGE	GENDER	RELIGION	ARTERY	IF YES, SIDE	DISTANCE (MM)
67	1398374	SS	07-12-22	22	M	sikh	N/A	absent	N/A
68	1426752	VS	10-12-22	39	M	sikh	N/A	absent	N/A
69	818886	RG	13-12-22	47	M	hindu	N/A	absent	N/A
70	1421358	MS	19-12-22	34	M	sikh	arterial	bilateral	R-51.04 ; L-52.79
71	245557	SK	19-12-22	64	F	sikh	N/A	absent	N/A
72	1433987	SK	19-12-22	49	F	hindu	N/A	absent	N/A
73	1432197	PS	19-12-22	63	M	sikh	N/A	absent	N/A
74	399825	VJ	20-12-22	63	M	hindu	N/A	absent	N/A
75	1228787	BK	20-12-22	42	F	sikh	N/A	absent	N/A
76	1432193	SS	21-12-22	42	M	sikh	N/A	absent	N/A
77	1429317	SR	21-12-22	46	F	hindu	N/A	absent	N/A
78	1412341	RS	22-12-22	50	M	sikh	N/A	absent	N/A
79	1435606	ML	24-12-22	62	M	hindu	N/A	absent	N/A
80	1388521	MM	27-12-22	30	F	hindu	N/A	absent	N/A
81	1286111	KC	27-12-22	39	M	hindu	N/A	absent	N/A
82	1491440	SK	01-01-23	37	F	sikh	arterial	left	56.03
83	1441370	SS	04-01-23	77	M	sikh	arterial	left	46.7
84	1328918	VK	04-01-23	46	M	hindu	N/A	absent	N/A
85	1429109	KS	04-01-23	52	M	sikh	arterial	right	55.52
86	1398348	LD	10-01-23	57	F	hindu	N/A	absent	N/A
87	1441834	GS	12-01-23	44	M	sikh	N/A	absent	N/A
88	1256811	SK	19-01-23	30	M	hindu	arterial	bilateral	R-52.96 ; L-54.7
89	1449068	JS	23-01-23	30	M	sikh	N/A	absent	N/A
90	1269677	BS	24-01-23	38	M	sikh	N/A	absent	N/A
91	1449520	NS	24-01-23	81	M	sikh	N/A	absent	N/A
92	1453034	SS	28-01-23	31	F	hindu	N/A	absent	N/A
93	1023749	SK	01-02-23	20	F	sikh	N/A	absent	N/A
94	833670	SS	03-02-23	68	M	sikh	arterial	right	52.83
95	520585	MK	03-02-23	68	F	sikh	N/A	absent	N/A
96	1456372	GS	04-02-23	30	M	sikh	N/A	absent	N/A
97	1455225	VD	04-02-23	67	F	hindu	N/A	absent	N/A
98	1458211	SS	07-02-23	48	M	sikh	N/A	absent	N/A
99	316814	MS	08-02-23	77	M	sikh	N/A	absent	N/A

S NO	MRD	NAME	DATE OF CT	AGE	GENDER	RELIGION	ARTERY	IF YES, SIDE	DISTANCE (MM)
100	1005263	SK	08-02-23	62	F	sikh	arterial	right	55.76
101	1424505	IS	08-02-23	19	M	sikh	N/A	absent	N/A
102	1157571	PD	09-02-23	64	F	hindu	arterial	left	60.61
103	1428008	PK	10-02-23	41	F	sikh	N/A	absent	N/A
104	1437678	KR	10-02-23	69	M	hindu	arterial	left	55.44
105	1460434	SK	10-02-23	57	M	hindu	arterial	left	51.22
106	1458921	PS	11-02-23	67	M	hindu	N/A	N/A	N/A
107	1456102	NG	14-02-23	31	F	sikh	arterial	bilateral	R-51.05 ; L-55.52
108	1464714	SK	17-02-23	51	F	sikh	arterial	absent	N/A
109	1462821	CD	17-02-23	51	F	hindu	N/A	absent	N/A
110	1464014	MK	17-02-23	50	F	sikh	N/A	absent	N/A
111	1413321	SK	18-02-23	66	F	hindu	N/A	absent	N/A
112	1432607	RS	18-02-23	65	M	sikh	N/A	absent	N/A
113	1463341	BN	18-02-23	81	M	sikh	N/A	absent	N/A
114	699417	DK	18-02-23	51	F	sikh	arterial	right	55.72
115	127596	SK	19-02-23	60	M	hindu	N/A	absent	N/A
116	1465912	RB	19-02-23	59	M	hindu	N/A	absent	N/A
117	1464867	MG	19-02-23	57	F	hindu	N/A	absent	N/A
118	1466725	RS	21-02-23	60	M	sikh	N/A	absent	N/A
119	1466909	JK	21-02-23	62	F	sikh	N/A	absent	N/A
120	1267295	VK	22-02-23	32	F	sikh	arterial	right	53.5
121	1467729	AK	22-02-23	55	F	sikh	N/A	absent	N/A
122	1468150	PH	22-02-23	28	M	christian	N/A	absent	N/A
123	507240	CK	23-02-23	45	F	sikh	arterial	right	74.47
124	1469051	AS	24-02-23	27	M	hindu	arterial	right	58.6
125	1353127	KK	24-02-23	22	F	sikh	N/A	absent	N/A
126	1420886	G	27-02-23	35	F	hindu	N/A	absent	N/A
127	1326787	DS	27-02-23	57	M	hindu	N/A	absent	N/A
128	1377272	GS	27-02-23	66	M	sikh	N/A	absent	N/A
129	1469214	MS	27-02-23	35	M	sikh	N/A	absent	N/A
130	1404648	AK	28-02-23	45	F	hindu	N/A	absent	N/A
131	1231620	JC	02-03-23	51	M	hindu	N/A	absent	N/A
132	1435089	BS	02-03-23	80	M	sikh	N/A	absent	N/A

S NO	MRD	NAME	DATE OF CT	AGE	GENDER	RELIGION	ARTERY	IF YES, SIDE	DISTANCE (MM)
133	1473495	KK	03-03-23	35	F	sikh	N/A	absent	N/A
134	66786	KR	05-03-23	57	F	hindu	N/A	absent	N/A
135	129925	NK	07-03-23	68	F	sikh	N/A	absent	N/A
136	1476024	RK	08-03-23	45	F	sikh	N/A	absent	N/A
137	1475372	SA	08-03-23	30	M	hindu	arterial	bilateral	R-59.95 ; L-58.11
138	1473470	SM	09-03-23	35	M	muslim	N/A	absent	N/A
139	1477016	PS	09-03-23	55	F	sikh	N/A	absent	N/A
140	1217907	JK	09-03-23	24	F	sikh	N/A	absent	N/A
141	1474132	SK	09-03-23	56	F	sikh	arterial	right	63.98
142	1450001	RJ	09-03-23	25	F	hindu	arterial	left	58.32
143	1476913	KS	11-03-23	14	F	hindu	N/A	absent	N/A
144	1476894	JK	11-03-23	64	F	sikh	N/A	absent	N/A
145	1479151	RK	12-03-23	30	M	hindu	N/A	absent	N/A
146	772501	PS	15-03-23	67	M	sikh	N/A	absent	N/A
147	1482968	KB	17-03-23	35	F	hindu	arterial	left	60.75
148	940045	RK	20-03-23	41	F	sikh	N/A	absent	N/A
149	1307974	HK	28-03-23	45	F	sikh	arterial	left	52.61
150	1382474	RBJ	31-03-23	66	M	hindu	N/A	absent	N/A

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The Principal
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Ludhiana

Subject:: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 25.09.2023 has approved the plan of thesis of **Harshaan Singh Pooni**, a student of your college for **MS Orthopaedics** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
Incidence and variation of corona mortis in Indian population .

Supervisor	Co-Supervisor:-	Co-Supervisor:-
Dr. Harpal Singh Selhi	Dr. Kavita Saggar	Dr.Meenakshi Aggarwal
Professor	Prof. & Head	Assoc. Professor
Dept. of Orthopaedics	Dept. of Radio-diagnosis	Dept. of Anatomy

The student may submit the thesis in triplicate alongwith the plan in triplicate also, to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She may be directed to attach a photocopy of this letter with the forwarding letter while submitting thesis in the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic, if any.

Controller of Examinations

Note :

1. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*

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INCIDENCE AND VARIATIONS OF CORONA MORTIS IN INDIAN POPULATION

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MS

IN

ORTHOPAEDICS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

AUGUST, 2022

DR. HARSHAAN SINGH POONI

DEPARTMENT OF ORTHOPEDICS
DAYANAND MEDICAL COLLEGE AND HOSPITAL
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ABSTRACT OF PLAN OF THESIS

Title	INCIDENCE AND VARIATIONS OF CORONA MORTIS IN INDIAN POPULATION
For the degree of	MS Orthopaedics
Name of the candidate	Dr. Harshaan Singh Pooni
Supervisor	Dr. Harpal Singh Selhi Professor, Department of Orthopedics, DMCH, Ludhiana
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Institution	Dayanand Medical College & Hospital, Ludhiana
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Introduction: The corona mortis, also known as the "crown of death", is a horrifying name that serves to represent the high risk of hemorrhage that may occur if this anatomical variant is injured and the difficulty of achieving hemostasis. Corona mortis is defined as an arterial or venous anastomosis between anastomotic branches of the obturator artery and the interior epigastric artery over the superior pubic ramus[1]. Patients with fractures of acetabulum and pelvic ring include young people sustaining high-energy trauma such as motor vehicle accident or falls from height and also there is risk of low-energy osteoporotic pelvic fractures in the elderly after minor falls. Early signs of vascular injury are clinical hypoperfusion, shock, lower abdominal swelling So, the presence of a corona mortis imposes threat and should not be overlooked in cases of these fractures [2].The bulk of the studies about the corona mortise were conducted in the cadavers or 3D CT angiography and very few studies were conducted about corona mortis in Indian population.

Aim of Study: To study the incidence and location of Corona mortis in anatomical specimens (cadaveric), radiological (angiography) and surgically during operative management of fractures of the acetabulum and pelvic ring.

Materials & methods: Patients admitted with fracture of acetabulum and pelvic ring which require open reduction internal fixation via ilioinguinal approach or modified Stoppas approach to acetabulum will be included in the study, 150 consecutive CT angiographies of pelvic vessels will be studied retrospectively and prospectively and 15 cadaveric hemi-pelvis will be dissected in the dept of anatomy to note the incidence, type of anastomosis and distance of anastomosis from pubic symphysis.

Clinical Significance: There is a paucity of literature on corona mortis in India. This study will help the surgeons by creating awareness and increasing knowledge about the presence of this anastomosis in Indian population.

Keywords: Corona mortis, acetabulum/pelvic fractures.

(Signature) Candidate	(Signature) Co-supervisor	(Signature) Co-supervisor	(Signature) Supervisor	(Signature) Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"INCIDENCE AND VARIATIONS OF CORONA MORTIS IN INDIAN POPULATION"** exist in the Department of Orthopedics at Dayanand Medical College and Hospital, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself under our supervision and guidance.

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APPROVAL PROFORMA
BY RESEARCH & ETHICAL COMMITTEE
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Name of candidate	Dr. Harshaan Singh Pooni
Department	MS ORTHOPAEDICS
Topic of Thesis	INCIDENCE AND VARIATIONS OF CORONA MORTIS IN INDIAN POPULATION
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Dr. Harpreet Kaur (Professor & Head, Pathology)	Mr. R K Sharma (Legal Expert)
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Approved: Yes / ~~No~~

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PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

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3	COURSE OF STUDY AND SUBJECT	MS ORTHOPEDICS
4	DATE OF ADMISSION OF COURSE	01/02/2022
5	TITLE OF THE TOPIC	INCIDENCE AND VARIATIONS OF CORONA MORTIS IN INDIAN POPULATION

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

The corona mortis, also known as the “crown of death”, is a horrifying name that serves to represent the high risk of hemorrhage that may occur if this anatomical variant is injured and the difficulty of achieving hemostasis. Corona mortis is defined as an arterial or venous anastomosis between anastomotic branches of the obturator artery and the interior epigastric artery over the superior pubic ramus.[1]

Corona Mortis possesses a surgical and clinical interest as it is susceptible to iatrogenic injuries during a great deal of surgical procedures (orthopedic access to treat acetabular fractures for instance). Moreover, there is great difficulty in achieving hemostasis when the corona mortis is injured during surgery. In addition, it can be ruptured in acetabular and superior pubic ramus fractures, thus, leading more complication to a patient’s health and cause severe hemorrhage.[2]

The obturator artery and its accessory (aberrant) arising from different origins and crossing the pubic rami are vascular variations. The obturator and accessory obturator arteries may arise from the external iliac artery and pass at the pubic rami. The vascular variation crosses the pubic rami and anastomoses with obturator artery arising from the internal iliac artery known as corona mortis. Therefore, corona mortis is a vascular connection between the external and internal iliac arteries.[3] It is located behind the superior public ramus at a variable distance from the symphysis pubis. This connection is usually regarded as arterial, but it may be venous or both venous and arterial [4]. Orthopaedic surgeons found these vessels in the field of surgery. So displaced fractures or iatrogenic injury, can cause life threatening bleeding and hence these vascular anomalies are referred to us crown of death. The heterogeneity of the studies included is not enough to extract safe results regarding the location of the vessel (left vs. right hemi-pelvis), as well as the presence of both the artery and vein. CMOR is more prevalent in patients from Europe than those from Asia

(48.75% vs. 34.09%).[4] This collateral circulation occurs due to either the inferior epigastric or accessory obturator artery arising from the external iliac artery joining the obturator artery arising from the internal iliac artery. Usually, the obturator artery arises from the anterior trunk of the internal iliac artery. Occasionally, it may arise from the external iliac or femoral artery instead of the internal iliac artery. Further, the obturator or accessory obturator artery may arise with the inferior epigastric artery from a common trunk of either the external iliac or femoral artery. Due to vascular variation, various studies done focus on the anatomical morphology of the obturator and accessory obturator arteries crossing over the pubic rami, and further categorizes them into several forms of corona mortis. It also helps to comparatively analyze the incidence of corona mortis in different populations.

The aim of current study is to provide sufficient data of vascular variability crossing the pubic rami for clinical field. Since this study will involve radiological locations, location of CM in cadaveric pelvis and during surgeries in real patients, it would be extremely useful for the orthopedicians and other surgeons to be careful regarding this important vessel and hence preventing life threatening bleeding and will enhance the awareness of orthopedics and surgeons to prevent iatrogenic errors in several pubic surgical procedures. The pubic rami fractures may lead to massive bleeding and ends with death. Consequently, the radiologists must alert the treating physicians to avoid intra-pelvic bleeding due to iatrogenic fault resulting from lacerating corona mortis. Accordingly, a great precaution has to be considered prior to surgical interference at the retropubic region such as internal fixation of pubic fracture.[5] This study will also estimate the incidence of corona mortis and its different forms in Indian population.

6.2 REVIEW OF LITERATURE

The common, external and internal iliac arteries are formed through a connection between the umbilical arteries and the fifth pair of lumbar intersegmental branches (pelvic plexus). This begins during the fifth week of embryonic development Branches of those vessels are formed as sprouts through a series of anastomotic channels, some of them enlarge, others diminish in size, thus, variations in the caliber, origin and trajectory of these branches are quite common.[6,7]

Variations of the obturator artery and inferior epigastric artery are well described in the literature.[8,9] Corona mortis incidence varies from 12 % to 40% in most recent studies.[10-13]

Furthermore, the corona mortis can be injured in pubic and acetabular fractures. Both types of trauma have a relatively high incidence among the elderly, hence, awareness of the corona mortis is of great significance as to reduce delay in treatment of the hemorrhage. The exact definition of corona mortis remains controversial until today. First, in their study, Damanis et al stated that there are three anatomical structures that cross the pubic ramus on its posterior area, namely, an artery or a vein and an aberrant obturator artery. Today, most anatomical textbooks support that corona mortis is an anastomotic vessel between the obturator and external iliac or inferior epigastric vessels. There are also some authors suggesting that corona mortis is a clinical rather than anatomical structure. The recent data obtained show that it is more common to find an abnormal obturator artery than was reported previously, and this observation has implications for pelvic surgeons and is of academic interest to anatomists.[5] Knowing the variability of the double obturator artery origins (corona mortis) is clinically significant. Over two centuries, the obturator artery crossing over superior pubic ramus has been studied in different researches. [4]

The obturator artery crossing the pubic rami is reported in following research studies.[3] the obturator artery can be classified into three types based on its origin. The first type is the obturator artery arising directly from the external iliac artery.[14,15] The second type is the

obturator artery arising indirectly from the external iliac artery. The second type is divided into two subtypes according to origin morphology. The first subtype is the obturator artery arising from the inferior epigatric artery ranging between 14% and 33%.[3], The incidence of obturator artery arising from the inferior epigastric artery is found to be from 2.6% to 44%.[14, 16-19]

Karakurt et al. 21 reported a distance of the corona mortis from the symphysis pubis with a range from 21.4 to 41 mm, the majority of researchers have concluded that, although the distance varies, it exceeds 30 mm.[20-22]

CM rupture can result in life-threatening hypovolemic shock even though SPR fractures do not usually require surgical treatment. Patients with pubic ramus fracture include young people sustaining high-energy trauma such as motor vehicle accident or falls from height and elderly people after minor falls Early signs of vascular injury are clinical hypoperfusion, lower abdominal mass in the abdomen. Clinically, the corona mortis can be easily ruptured in cases of acetabular and SPR fractures and cause severe hemorrhage. This is a concern, since incidence of low-energy osteoporotic pelvic fractures in the elderly are quite high.[4] Thus, the presence of a corona mortis imposes threat and should not be overlooked in cases of these fractures.

Recent studies showed that the corona mortis if one of the structures that the surgeon must observe during modified Stoppa approaches. Among other structures that should be identified are the external iliac artery and the superior gluteal neurovascular bundle.[23]

Traditional, modified Stoppa, ilioinguinal and iliofemoral approaches are often used to treat acetabular and pelvic ring fractures, with a fairly good success rate (70-95 %) and low rates of complications. Despite that, some studies showed vascular injury rates of 6.2 % of patients with corona mortis.[4,23]

Modified Stoppa access have vantages such as smaller surgical incision and soft parts dissection and allows the surgeon to place the implant directly at the internal surface of the pelvis, thus, possessing

less complication rates. Thus, knowledge of the incidence, size and anatomical relations of the corona mortis is essential, especially to orthopedic surgeons, as modified stoppas approach is most common method of access to acetabulum anteriorly in orthopedic procedures. This knowledge is necessary in order to avoid complication rates due to iatrogenic rupture of this vessel.

To do preoperative CT angiogram is helpful to knowing the site, size and type of corona mortise in both hemipelvies in the patients who have it.

6.3 AIMS AND OBJECTIVES OF THE STUDY

To study the anatomical, radiological and clinical variations of Corona Mortis in North Indian population.

Specific objectives:

1) To study the incidence rate of corona mortis

2) To identify the type of the anastomosis i.e. arterial or venous or both.

3) To determine the location of corona mortis by measuring the distance between pubic symphysis and the anastomosis.

7.0 MATERIALS AND METHODS

7.1 SOURCE OF DATA: For radiological evidence of corona mortis vessel, retrospective and prospective 150 consecutive CT angiographies will be taken and studied to know the incidence, type and site based on distance between pubic symphysis and the vessel. Fifteen cadaveric hemipelvis will be seen in dept of anatomy, DMCH, for study of this vessel. Also all patients with injuries to the pelvis with acetabulum fracture needing open reduction and internal fixation will be included prospectively over a period of 15 months w.e.f.15th September 2022 as well as one year retrospectively from 15th Sept 2021-15th Sept 2022.

7.2 METHOD OF COLLECTION OF DATA:

It will be descriptive cross sectional hospital based study over period of 18 months. Information will be written in the proforma attached.

Inclusion criteria

- Consecutive 150 CT angiographies of pelvis where iliac vessels are seen.
- Fifteen cadaveric hemipelvis will be studied in the dept of Anatomy to know the incidence, type and site based on distance between pubic symphysis and the vessel.
- Patients admitted with fracture of acetabulum and pelvic ring who require open reduction and internal fixation via ilioinguinal approach or modified Stoppas approach to acetabulum

Exclusion criteria

- Previous surgery where it may have been ligated/encountered.
- Patients with developmental disorder/deformity or arterio-venous malformation.

Duration of study: this study will be done prospectively over 15 months and 1 year retrospective.

STUDY DESIGN: Descriptive cross-section hospital based study will be conducted in Dayanand medical college and hospital. The study will be over a period of 15 months with effect from 15th September 2022 and one year retrospective. In addition Standard predesigned

structured proforma will be filled in direct interview with patient, intraoperative finding check list was completed by author.

STATISTICAL ANALYSIS: Data will be described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations will be done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

None

7.4 HAS ETHICAL CLEARENCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Yes, Attached herewith.

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PROFORMA (Clinical Cases)

S NO: ____

NAME: AGE: SEX:

ETHNICITY: CASTE: RELIGION:

MRD No: Admission no:

Date of Admission:

Nature of injury:

CLINICAL DIAGNOSIS

CHIEF COMPLAINTS:

ON EXAMINATION:

HR: RR: BP:

INVESTIGATIONS:

Ventilator support: Yes/No

Inotropic support: Yes/No

FINAL DIAGNOSIS:

Intra-op findings: Ilioinguinal- / modified Stoppas

Corona Mortis present -

Type -

Distance from pubic symphysis -

PROFORMA (Radiological)

S NO: ____

NAME: AGE: SEX:

ETHNICITY: CASTE: RELIGION:

MRD No:

DATE OF CT:

CHIEF COMPLAINTS:

PROVISIONAL DIAGNOSIS:

CT angiography:

Corona Mortis present -

Type -

Distance from pubic symphysis -

PROFORMA (Anatomical)

S NO: ____

Specimen No-

Approx Age-

Sex-

Hemi-pelvis findings:

Corona Mortis present -

Type -

Distance from pubic symphysis -

INFORMED PATIENT CONSENT

Date: _____

I……..D/o,W/o,S/o…… ……. ……am willing to participate in the study **"INCIDENCE AND VARIATIONS OF CORONA MORTIS IN INDIAN POPULATION"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

…… ……

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____ इस शोधकार्य "**INCIDENCE AND VARIATIONS OF CORONA MORTIS IN INDIAN POPULATION"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक केहस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____ ਵਾਸੀ _____**"INCIDENCE AND VARIATIONS OF CORONA MORTIS IN INDIAN POPULATION"** ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ–ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ